The Foundry Trade Journal

AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

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THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

WE INVITE PRACTICAL ARTICLES ON THE TRADE IN ALL ITS BRANCHES, WHICH WILL BE PAID FOR. MSS. SHOULD BE WRITTEN ON ONE SIDE OF THE PAPER ONLY.

BRITISH FOUNDRYMEN'S ASSOCIATION.

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Forthcoming Events.

AUGUST 2, 3, AND 4.
British Foundrymen's Association.—Annual Convention at Manchester.

SEPTEMBER 27, 28, AND 29.
Iron and Steel Institute.—Autumn Meeting at Buxton, Derbyshire.

NOTES AND COMMENTS.

The Progress of the British Foundrymen's Association.

The move that was made at the last Convention of the British Foundrymen's Association, to rearrange the membership fees, with a view to embracing a greater number of the foundry workers, appears to have been very successful; for since the last report of the Council in 1909, the membership has increased from 448 to 571. During the year 43 members, 83 associate members and 32 associates have been elected, but during the same period were recorded the resignations of four members and 31 associate members, giving a total accession of 123 to the membership. These figures speak well for the strength of the educational movement amongst our foundrymen, and if the progress is maintained the Association bids fair to wield considerable influence in the metallurgical world. That it has already become recognised as representing the technical interests of the foundry trade, is shown by the appointment of one of its members (Mr. Pilkington), as a representative on the Committee of the International Association for Testing Materials. In the capacity of the foundrymen's representative, Mr. Pilkington presented to that Committee important information and suggestions on the subject of pig-iron specifications based on analysis. This is doubtless only one of the instances in which the British Foundrymen's Association will be called upon to speak for the foundry trade, and we should like to see them ever to the front in all matters affecting the industries in which they are engaged, or to which their work contributes. Drawing, as they do, their members from the best ranks of the foundry workers—the ranks that recognise the industrial value of education—they can certainly claim to represent the interests and requirements of their progressing industry as no other body can.

The Advantages of Fraternizing.

There is another feature—the increasing willingness of men to fraternise on matters relating to their work—which marks the progress of the present age. Each commercial undertaking of to-day presents its own set of problems, and intelligent minds are continually grappling with new difficulties which arise with the advancement and development of manufacturing processes. The problems that present themselves are not only of a technical and mechanical nature; frequently they concern rather the relation between worker and master, and involve the harmonious or otherwise operation of a works. In treating with the question of trade difficulties, one is apt to relegate such matters as the status of the worker, to the realm of sociological topics, which are not to be discussed by technical gatherings, and while it is admittedly dangerous to tread certain paths of discussion of this nature, there are many phases which might be thrashed out without fear of wounding individual susceptibilities. It is becoming more apparent every day that the satisfactory progress of any work is greatly dependent on the relation the worker assumes to the work. This fact has been acknowledged in

various papers read before the British Foundrymen's Association, and must not be overlooked in the race for mechanical and scientific achievement. Such matters of what might be termed a domestic character, are best discussed dispassionately between men of varied experience, for under such conditions individual prejudices are more or less subjugated. It is in dealing with such questions as these that the fraternal spirit created by association under conditions which make for mutual assistance, is particularly helpful. We are aware that we have at times advocated the avoidance of such topics as, say, the relation of the Trade Unions to employers, and it will probably be generally conceded that such matters are best left alone by technical societies; but matters touching the attitude of the individual employer or his foreman to their subordinate workers as individuals, should not be placed under the same prohibition. To consolidate the interests of the whole of the operatives of a manufacturing concern, and to create the best possible relation between the different grades and the employer is an important and desirable aim; and in gatherings where all the various grades of men concerned meet on terms of equality for mutual aid, excellent work might be done in solving the many vexed problems that occur from time to time. This is, of course, somewhat apart from the technical questions that arise for consideration. That the latter are dealt with to the advantage of all concerned is well known by all members of such societies as the British Foundrymen's Association. Until comparatively recently the foundryman—and in this respect he may be taken as typical of most craftsmen—had to grapple alone with his working difficulties, often wasting valuable time as well as material in experimenting and puzzling over questions which his experience had not previously embraced; and this, too, when other men about him probably held the key to his difficulties. In fact, it has been quite a common thing for a new-comer in a shop to be left to flounder in difficulties that those working at his elbow had already solved. But the spirit of fraternity was not sufficiently strong to extend aid, and the sentiment of one man to another was, "Let him learn by experience and trouble as I have done; I will not give him the knowledge I have had to buy with hard work and unpleasant experience." But that attitude is gradually giving way to the conciousness that no man's experience can possibly cover all the requirements of the trade, and that to give is but to receive in return.

The Value of the Electrical Iron-Smelting Furnace.

The possibilities associated with the application of the electric furnace for the production of steel for foundry and similar work have been dealt with so freely of late, that the electric process is accorded a prominent place in the iron and steel industries. But not so well-known are the possibilities of the electric furnace for the smelting of iron-ore and the production of pig-iron. From the particulars which we have published from time to time, it will be gathered that, despite the fact that this process is still in the experimental stages, there is an important future before it. In this connection it is interesting to note the opinions expressed in a paper on the "Theoretical and Practical Value of the Electrical Iron-Smelting Furnace," by Carl Brisker (Leoben University), read before the recent International Congress of Mining and Metallurgy, at Düsseldorf. An abstract of the paper is as follows:—

"I have examined the conditions of working of the electric iron-smelting furnace at the iron works at Domnarfvets, Sweden, with a view of ascertaining the rate of reduction and the heat consumption, and have thus been able to state clearly the important part played by the upper portion of the furnace, or shaft, in the conduct of the process. It is evident that the fuel charge does not suffice to carry out reduction, when this is not facilitated by conditions which favour a decomposition to carbon and carbon dioxide of the carbon monoxide formed. This decomposition occurs in the shaft, and is promoted by lowering the actual temperature of working, the current of gas flowing up the shaft then coming into play. It does not, so far, appear to be fully recognised that the furnace shaft is an essential feature, for this purpose at all events. That the parting of the carbon from the carbon monoxide gas-current is necessary to complete reduction, is evidenced both by the formulæ, and also in actual practice, since there occurs a considerable increase in the temperature of the gas-current through the furnace shaft, which can only be traced to this heat-developing reaction. The figures of heat given in the Paper, compared with those for a process of a similar nature in a blast furnace using coke, indicate an efficiency for the electric smelting furnace of from 65 to 66 per cent., as against 76 per cent. in the coke blast furnace (the figures being calculated taken into consideration the value of the furnace gases). They therefore show, with reference to the electric smelting furnace, a most favourable result; and here it should be pointed out that they apply to a first experimental installation, for a comparatively small output, and one in which losses by radiation and water-cooling were far too great. For larger outputs the heat utilisation will be much more favourable; with electric smelting furnaces, moreover, it will be an easy matter to smelt as much as 75 per cent. of small ore. Seeing also that with the electric smelting furnace the product obtainable can be regulated, in regard to composition, over a much wider range than is possible with the blast furnace, while being characterised by a special degree of purity, I consider the electric smelting furnace to be, even now, able to hold its own in general competition in those places where electric power can be produced at a reasonably low cost."

Vanadium in Cast Iron.

According to a Paper read recently before the New England Foundrymen's Association, by Mr. G. L. Norris, the New York Central and Hudson River Railroad have required vanadium cast iron for the cylinders for 183 new locomotives built for that line recently. This decision was arrived at as a result of a two years' test of a pair of cylinders made of this cast iron, during which the engine ran 200,000 miles with only microscopical wear of the cylinders. This is much less than the results of ordinary cast iron. Comparative tests made by the builders, the American Locomotive Company, of the ordinary and the vanadium cast iron used for cylinders showed that for transverse tests, made with 1-in. square machined bars on 12-in. supports, the plain cast-iron bars averaged 2,130 lbs., and the vanadium cast-iron bars 2,318 lbs. Tensile tests made with machined bars resulted in an average of 24,225 lbs. for the plain cast-iron bars, and 28,728 lbs. for the vanadium cast-iron bars. In making vanadium cast iron, Mr. Norris says ferro-vanadium should be used containing under 35 per cent. of vanadium. In the case of cupola-iron, the addition of 0.10 to 0.12 per cent. vanadium is all that should be attempted, but in high-grade air-furnace iron the addition of 0.18 to 0.20 per cent. is readily accomplished. It is stated that about 70 or 80 per cent. of the vanadium remains in the iron, the remainder being used up in purifying the melt.

Automatically Circulating Furnaces for the Electrical Production of Steel.*

By Gustave Gin.

Gin Induction Furnace.

In induction furnaces, with an open connecting channel, it is difficult, on account of the small heat conductivity and of the slowness with which the molten bodies diffuse, to obtain a uniform distribution of either the heat or the purifying reactions. A much better result is obtained from the technical point of view by keeping the molten material in continual circulation, as this causes a mixture of all the parts and brings fresh surfaces of the reacting bodies into contact. Such a circulation has been obtained by Schneider in the furnaces described in the American Patent No. 761,920, and by the author in the arrangement protected by Patent No. 875,801. The latter furnaces are characterised by a converter which is composed of two crucibles, both partly filled with the molten material, and of communicating inclined channels, wholly filled with this material. The whole arrangement forms a closed circuit, through which the heat generated causes a general circulation. This continues owing to an ascending movement which occurs in the connecting channels, and is transmitted through the whole molten mass.

The accompanying cuts, Figs. 1, 2, 3, and 4, show a model furnace which the author designed with the assistance of MM. Schneider et Cie, for construction at the Krupp Works in Essen. This furnace consists of two crucibles, *a* and *b*, connected by the heating channel, *c*. The larger of these crucibles, *a*, is known as the working crucible, and is fitted with a draw-off door, *e*, for the slag, and a pouring funnel, *f*, for the steel. The inducing circuits, *d*, surround the two heating channels and are cooled by forced ventilation.

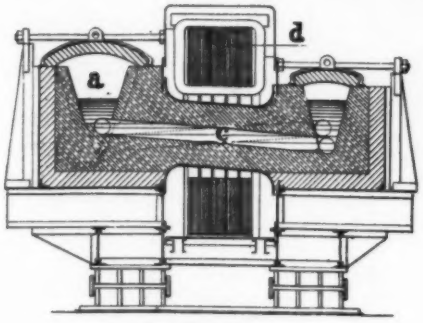


FIG. 1.

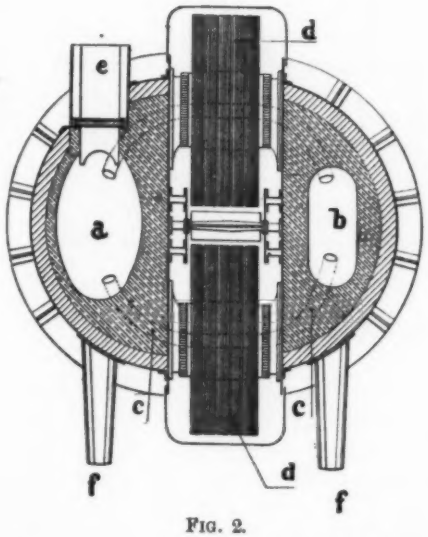


FIG. 2.

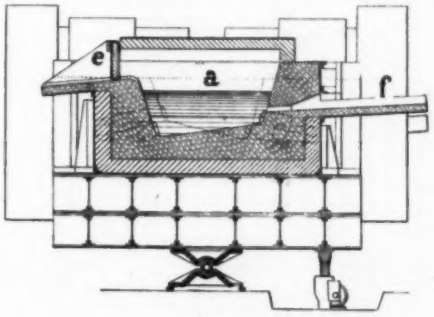


FIG. 3.

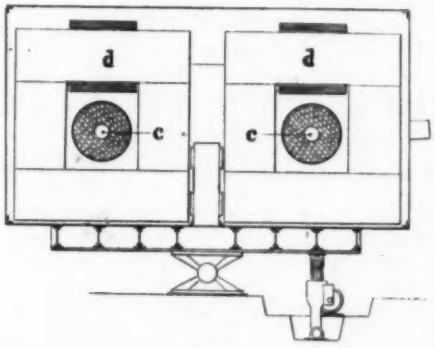


FIG. 4.

THE GIN INDUCTION ELECTRICAL FURNACE.

* Abstract of Paper read before the Faraday Society.

To facilitate pouring and the withdrawal of the slag the whole furnace can be turned about an axis by means of an electrically-driven worm. It is easy to understand why such a furnace should be better from a technical point of view than one with an open connecting channel. The heating is uniform throughout the furnace, and a very high temperature can be obtained without any fear of introducing the "pinch phenomenon" in the heating channels. Every portion of the molten mass comes successively, and at a rapid rate, into contact with the oxidising slag, thus permitting a much more rapid and complete purification than can be obtained in ordinary furnaces. The speed reached in the channels varies according to their gradient and diameter, but the arrangements are so designed that a minimum velocity of about 16 in. per second is obtained.

In induction furnaces with an annular channel the co-efficients of self- and mutual-induction increase with the dimensions of the secondary circuit, and, therefore, with the capacity of the furnace. This makes a reduction in the frequency of the primary current necessary and leads to the employment of generators and transforming apparatus abnormal in dimensions, weight, and size. With the automatically circulating furnace the ohmic resistance of the circuit can be increased without correspondingly altering its self- or mutual-induction, thus allowing furnaces with a satisfactory power factor to be obtained, and generators and transformers of normal frequency, weight, and price to be employed.

The furnace shown in Figs. 1 to 4 is constructed for a power of 420 kw. The primary current is supplied at an average pressure of 4,800 volts, and its frequency is reduced to five per second. The capacity of the furnace is five tons.

In some electric furnaces which are applied to the production of steel, the arc plays between one or more electrodes and the bath it is desired to heat. If the current pass from one electrode to the bath and thence to a second electrode which is movable like the first, a purely superficial heating is obtained by means of two arcs in series. This is favourable to a high temperature of the slag, but produces an incomplete and non-homogeneous heating of the molten metal in the bath. If the current from a single electrode pass through the bath to leave by a conducting hearth, an amount of heat is set free in the mass traversed which is proportional to the electrical resistance of this mass. But if a metal like iron, whose resistance is comparatively low, is being worked with, this quantity of heat is practically negligible, and the useful effect is reduced to the superficial heating produced by the arc between the electrode and the surface of the bath.

In both cases the thermal efficiency is low, for the heat conductivity of liquids is small, and the ascending and descending currents which are produced when the source of energy acts on the lower part of the bath cannot be used for the transmission of heat. This disadvantage is remedied by causing the molten mass to be artificially circulated. To obtain this circulation the author has designed an induction furnace made up of a series of crucibles, partly filled with the molten material, and connected by communicating inclined channels which are completely filled with the molten mass. The same principle can be employed in electrode furnaces.

The simplest application is shown in Figs. 5 and 6, which illustrate a furnace made up of two crucibles, *a*, connected by inclined channels, *b*, sloping in opposite directions. In the two crucibles are placed the electrodes, *c*, which are connected to an electricity supply. The current passes from the electrode into the bath in the first crucible, and from there into the other bath through the channels, *b*, which serve as conductors both of electricity and heat. Lastly, the current passes from the bath in the second crucible to the corresponding electrode. On account of the heating which is produced in the communicating tubes, and the difference of level which exists between their two ends, the molten mass rises in them and passes from the first furnace to the second by one of the tubes and in the opposite direction by the other, so that a continuous circulation and even heating is obtained.

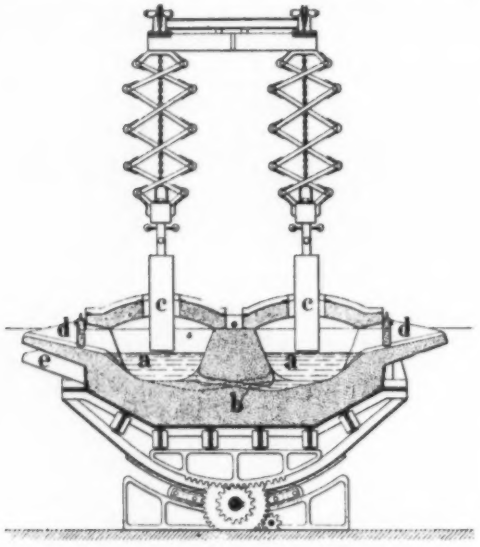


FIG. 5.

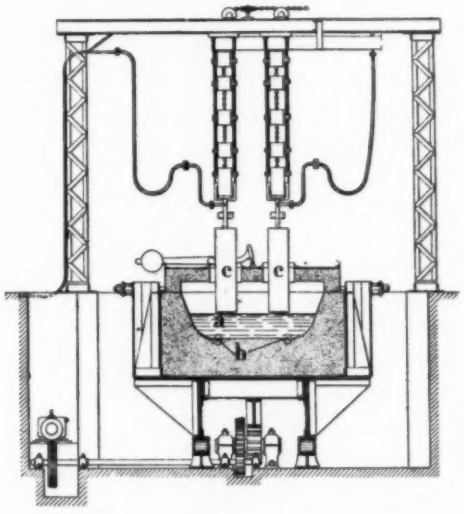


FIG. 6.

THE GIN ELECTRODE AND AUTOMATICALLY CIRCULATING FURNACE.

British Foundrymen's Association Convention.

The seventh annual Convention of the British Foundrymen's Association will be held at Manchester on August 2, 3, and 4. By kind permission of the authorities the meetings will be held in the Municipal School of Technology, Sackville Street, Manchester. The Right Hon. Lord Mayor of Manchester (C. Behrens, Esq.) will welcome the members at 10 a.m. on Tuesday, August 2. A strong local Committee has been formed, consisting of the following gentlemen:—Messrs. R. W. Kenyon (Chairman), G. Buchanan, T. W. Markland, J. Penlington, W. H. Sherburn, J. Simkiss, H. S. Skelton, W. Wright, W. Smalley, T. W. Holt, J. H. Kain, Professor H. C. H. Carpenter, Messrs. E. C. Rhead, Mills Palmer, D. Cordingly, F. Critchley, J. J. Chipchase, C. A. Edwards, J. Kenyon, H. Sherburn (Hon, Secretary), A. Liedig (Assistant Hon. Secretary).

The headquarters of the Association will be at the Grand Hotel, Deansgate. The Council and local Committee will be in attendance at 7 p.m. on Monday, August 1, to assist members.

Report of the Council.

The annual report of the Council for the year 1909 is as follows:—

The Council have pleasure in presenting to the members the following report of the progress and work of the Association during the past year.

Our Past-President, Mr. H. Pilkington, M.I.C.E., M.I.M.E., has been appointed as our representative on the Committee of the International Association for Testing Materials. A meeting of the British members and representative of Associations was held in the offices of the Iron and Steel Institute, 28, Victoria Street, London, on Thursday, February 10, 1910 at 4 p.m., under the chairmanship of our Honorary Life Member, Mr. J. E. Stead, F.R.S., F.I.C., F.C.S., to consider the resolution of the Copenhagen Congress relating to the grading of pig-iron, *i.e.*, "That for the purpose of defining more accurately the quality of pig-iron than is possible by the present method of grading by fracture appearance, the Congress recommends that Committee I. (Sub-Committee Ia.) be instructed to inquire in the various countries concerned, as to how far specifications on analysis may be usefully substituted for the present method of grading by fracture appearance, and that they may be authorised to take such steps as they may deem advisable to give effect to this resolution."

After a lengthy discussion the following resolution was passed: "That the conditions governing the sale of pig-iron in Great Britain make it undesirable to recommend any immediate change in the existing practice of grading, whether by fracture or by analysis." This will be brought forward at the next Congress, which will be held in the United States in 1912.

The alteration in membership suggested by the Council and passed at the annual meeting in 1909 has proved most successful, showing an increase in membership, and the number on the roll at the present time is seven honorary life members, four life members, 120 members, 320 associate members, 120 associates, making a total of 571, as compared with a total number of 448 for year 1909. During the past year four members and 31 associate members have resigned, and 43 members, 83 associate members, 32 associates have been elected.

The accounts for the year ending December 31, 1909, are now submitted, having been duly certified by Messrs. H. Sherburn and G. Hailstone, the auditors appointed. The total revenue for the year was £184 0s. 4½d., while the expenditure was £179 16s. 11d., leaving a balance of revenue over expenditure of £4 3s. 5½d. This, with the balance of £48 0s. 9d. brought forward from the year 1908, leaves a balance in hand of £52 4s. 2½d.

British Foundrymen's Association. Sixth Annual Balance Sheet, 1909.

INCOME.
January 1st to December 31st, 1909.

	£	s.	d.
Balance from 1908	48	0	9
Interest do.	0	16	0
Our Book, 1907	0	1	6
Arrears Subscriptions, 1908	1	10	0
Subscriptions, 1909:—			
2 Life Members at £5 5s. 0d.	10	10	0
44 Members at £1 1s. 0d.	46	4	0
17 Associate Members at £0 10s. 6d.	8	18	6
272 ,, at £0 7s. 6d.	102	0	0
79 Associates at £0 3s. 0d.	11	17	0
Remittance from Birmingham Branch	2	3	4½
	£232	1	1½

EXPENDITURE.
January 1st to December 31st, 1909.

	£	s.	d.	£	s.	d.
Postage				12	3	0
Printing and Stationary				12	4	2
Council Expenses				8	7	4
Printing Proceedings				47	12	7
Branch Expenses:—						
Birmingham	5	0	0			
Manchester	5	8	1	26	9	1
Sheffield	16	1	0			
Expenses Annual Meeting				21	11	9
Registration Amended Rules				0	10	0
Illuminated Address Mr. Pilkington				4	14	6
Honorarium to Secretary				20	0	0
Secretary's Expenses				4	4	6
Clerical Assistance				2	2	6
Arrears Subscriptions:—	£	s.	d.			
3 Members at	1	1	0			
25 Associate Members at	0	7	6	19	17	6
49 Associates at	0	3	0			
Cash in Treasurer's Hands				0	5	3½
,, ,, ,, Manchester Branch				2	9	8
Cash in London City and Midland Bank				49	9	3
				£232	1	1½

Audited and found correct,
H. SHERBURN,
G. HAILSTONE.

F. W. FINCH, Treasurer
J. E. H. ALBERT, Secretary.

A new Branch has been formed in Scotland.

The Secretary attended a Committee meeting at Glasgow on March 19, at which Mr. Campion, F.I.C., F.C.S., of the Glasgow and West of Scotland Technical College, presided. The Secretary explained the objects of the Association and its progress since its inception, after which rules were drawn up and officers nominated. The first general meeting was held on March 28 at the Technical College, Glasgow, the attendance being about one hundred. Bailie J. King, Keppock Ironworks, Glasgow, was elected President, and F. A. Ewen, of Messrs. Douglas & Grant, Kirkcaldy, was elected Secretary. Our first President, Mr. R. Buchanan, F.R.S.A., attended the meeting, and gave a Paper on "The Cupola," which was well received.

The Council are now arranging programmes for the next Session, and are looking forward to the Scottish Branch being a strong and successful one, its headquarters being in Glasgow.

A Literary Committee has been formed to review all Papers given before the Association. This consists of the following gentlemen:—Messrs. R. Buchanan, F. J. Cook, R. W. Kenyon, P. Longmuir, and H. Pilkington. Any member desirous of giving a practical Paper will receive every assistance from the Committee.

The Council have pleasure in reporting that the Branches are doing excellent work. Very interesting

visits to works have been arranged during the Session, and the following Papers have been given before the Association during the year:—

Cook, F. J., and Hailstone, G., Birmingham, "Introduction to the Effect of Structure upon the Physical Properties of Cast Iron."

Edwards, C. A., Manchester, "The Production of Castings to Withstand Hydraulic Pressure."

Green, H. S., London, "Modern Foundry Appliances."

Greaves, H., B.Sc., Birmingham, "Modern Bronzes," "The Physical Properties of Foundry Coke," and "Carbon, its Properties and Relation to Cast Iron."

Hiorns, A. H., Birmingham, "Influence of Chemical Compounds on the Properties of Cast Iron."

Knowles, F. K., B.Met., Sheffield, "Heat Value of Fuels."

Mather, R., Middlesbrough, "The Scope of Science in the Foundry."

Markland, T. W., Bolton, "Crystallisation and the Effects of Various Elements on Cast Iron."

Matthews, J., Walsall, "The Production of Malleable Cast Iron."

Pemberton, H., Derby, "Production of Locomotive Cylinders."

Rhead, E. L. F.I.C., F.C.S., Manchester, "Coke for Foundry Use."

Shaw, J., Birmingham, "Moulding Sands."

Smith, S. G., Chesterfield, "The Application of Rule-of-Thumb and Science in the Foundry."

Sherburn, W. H., Warrington, "The Foundry and the Man," and "The Production of Patterns for Light Castings."

Turner, Prof., T., M.Sc., A.R.S.M., F,I,C,, Birmingham, "Twenty-Five Years of Cast Iron."

The Council desire to thank the proprietors of the works visited for their kindness in allowing these visits, also the gentlemen who have kindly given Papers during the Session.

During the year the Council have held six meetings, and members have attended from Accrington, Birmingham, Butterley (Derby), Cardiff, Chesterfield, Gloucester, Horsehay (Shropshire), London, Leicester, Rugby, Sheffield, Stafford, Southampton, and Warrington, and matters of importance to the Association have been thoroughly discussed.

Six members of the Council are retiring, but are eligible for re-election. The following gentlemen have been nominated:—S. A. Gimson, Leicester; T. Macfarlane, Horsehay, Shropshire; J. Oswald, London; W. H. Sherburn, Warrington; J. Smith, South Shields; R. Mason, Leicester; T. H. Firth, Brightside Foundry Company Limited, Sheffield; G. B. Henderson, John I. Thornycroft, Limited, Southampton. The first six named are retiring members.

Programme of Forthcoming Convention.

TUESDAY, AUGUST 2.—9.30 a.m., business of Association, election of officers, etc.; 10 a.m., municipal reception by the Lord Mayor of Manchester; Presidential address. Papers:—"The Cupola," by R. Mason; "Cupola Slags," by T. Swinden, B.Met.; "The Properties of Coke," by F. K. Knowles, B.Met.; "Hardness Testing of Cast Iron," by R. Mather, B.Met. Afternoon.—Visit to the Locomotive Works of the Lancashire and Yorkshire Railway Company, at Harwich.

WEDNESDAY.—9.30 a.m., Papers:—"Malleable Cast Iron," by G. A. Blume, Sweden; "Theory Underlying Malleableising," by W. H. Hatfield, B.Met.; "The Electric Furnace," by W. S. Gifford, Assoc.R.S.M.; "Brass Alloys," by O. F. Hudson. Afternoon.—Visit to the works of Messrs. Tweedale & Smalleys, Limited, Castleton.

THURSDAY.—Picnic to Chester and Eaton Hall (members intending to join this must notify the local Secretary on or before August 2).

FIG. 1.—VIEW IN THE CHAIR, BRAKE-BLOCK AND GENERAL FOUNDRY, TEES IRON WORKS; MESSRS. WILSONS, PEASE & COMPANY, LIMITED.

A Tees-side Foundry.

The Tees Iron Works, of Messrs. Wilsons, Pease & Company, Limited, situated on the south bank of the River Tees, are nearly the oldest in the district, having been established in 1853. The original firm was Gilkes, Wilson, Leatham & Company, who gave the name to the pig-iron brand of "G.W.L.," which has been retained ever since, and is now recognised as one of the best of the "Cleveland" brands of iron.

The blast-furnace plant consists of three blast furnaces, 84 ft. high by 23 ft. 6 in. diameter of bosh and 11 ft. diameter of well, with an internal capacity of about 24,000 cubic feet, and each capable of producing about 800 tons of pig-iron per week, smelted entirely from Cleveland ironstone. These furnaces

FIG. 2.—VIEW IN THE DIRECT-CASTING FOUNDRY AT TEES IRON WORKS; MESSRS. WILSONS, PEASE & COMPANY, LIMITED.

are supplied with blast at about 7 lbs. per square inch pressure by a Parson's steam turbo-blower, a Yates & Thom cross-compound vertical blowing engine, and two tandem vertical compound engines, all worked condensing. Steam is supplied at 150 lbs. pressure by six Babcock & Wilcox and two three-flued Lancashire boilers, fired with blast-furnace gas, and having specially arranged external combustion chambers. The blast is heated to about 1,400 degrees F. in 10 Cowper stoves, and enters each furnace through eight tuyeres 6½ in. diameter at the nozzle. The main hot-blast valves are 24 in. diameter, and are fitted with cast-iron tongues made at the works under the special direct-casting process, which produces castings peculiarly well suited for situations exposed to high temperatures.

The ironstone used in the furnaces is calcined in nine kilns of the modified Gjers type, arranged for filling the barrows with a minimum of labour. The furnaces are charged by means of two hoists worked with wire ropes, one hoist being driven electrically and the other by steam.

The works are lighted throughout by electricity, generated for this and for power purposes by two generating sets, one being a Belliss & Morcom compound steam engine coupled direct to a 195-kilowatt dynamo, and the other a triple-expansion marine-type engine driving by means of belts two dynamos, each of 140-killowatt capacity, the current from both sets being "direct" at 230 volts.

The shipping wharf (shown in Fig. 3) has recently been entirely reconstructed and lengthened, and the berth dredged out, so that there is now a frontage of 300 ft., and vessels of fully 360 ft. in length can be accommodated. There is 12-ft. depth of water at low tide in ordinary spring tides, and fully 26 ft. at high tide. The wharf is furnished with two quick-acting electric cranes of 40 ft. radius, capable of handling weights up to 5 tons, and one steam crane, whereby shipping operations can be carried out with the utmost despatch.

The foundry department (shown in Fig. 1) has always made a speciality of railway chairs of all kinds, and in recent years has greatly developed the manufacture of cast-iron brake blocks for railways and tramways, having lately introduced a special form of brake block with a steel back which is much stronger and more durable than the ordinary cast-iron block, and can be worn down very much thinner without losing its efficiency and without risk of accident through breakage. The scrap on the worn-out block is thereby reduced to a minimum, while the changing of an old block for a new one is a quick and simple operation.

The supervision of a skilled laboratory staff enables

the firm to produce various special qualities of metal to suit the varying conditions of railway and tramway service, and machine-moulding enables them to turn out railway chairs and other repetition work rapidly and with a high degree of finish. The moulding machines for chairs and other light articles are worked by hand, while those for heavier work, such as colliery tubbing segments, are operated by hydraulic power.

For ordinary jobbing moulding, the main foundry is fitted with four cranes of up to 5 tons' capacity, used in the production of girders, wheels, tank plates, colliery tubbing, columns and other classes of castings for engineering, ship yards, collieries, railways, tramways, etc., one of the various specialities being a patent tramway anchor chair. This foundry is served by five cupolas, the blast being supplied by two Roots blowers, one driven electrically and the other by steam. The two cupola hoists are operated by direct-acting steam cylinders. A portion of the burnt sand from the foundry is mixed with fresh loam and coal dust, and the whole thoroughly incorporated in centrifugal mixers driven electrically, and used over again for moulding purposes. The foundry is lighted throughout by electric arc and incandescent lamps.

In order to provide more room for making chairs and other repetition work, and at the same time to enable larger castings to be produced, a new foundry 200 ft. by 72 ft. has just been erected.

The production of direct castings is a comparatively new development of the foundry business. In this mode of working, the pattern-making and moulding are just the same as in the ordinary foundry; but the iron, instead of being re-melted in the cupola, is cast direct from the blast furnace. This yields castings of a more grey and open texture, which are found peculiarly suitable for work exposed to high temperatures, such as in hot-blast stoves and valves, annealing pans, furnace doors, tuyere pipes, etc. These castings are also largely used for street manholes, gullies, gratings, etc., and can be produced more cheaply than ordinary foundry castings, as the cost of the second melting of the iron is avoided. The metal is run direct from the blast furnace into ladles of 4 tons' capacity, which are handled by 5-ton overhead electrical travelling cranes. A view in the direct casting foundry is shown in Fig. 2.

A still cheaper class of casting is made on the furnace pig beds, without moulding boxes, and run direct "in the open" from the blast furnaces. Floor-plates bending blocks, fire bars, stove grids, and standards, cart-road plates, etc., are thus cast; and an extensive business is done in this class of castings.

VOLUME AND WEIGHT OF ALLOYS.—The density of pure metals usually varies between certain extremes; in general, however, rolled metals have a greater density than the same material cast, but the difference can, as a rule, be expressed in tenths of 1 per cent. With alloys, however, the differences in density are much more marked. There are some, the actual density of which is greater than that which one would calculate from those of the component parts; and the contrary is sometimes the case. In fact, alloys may be considered as mixtures of two liquids which unite in all possible proportions. With some liquids there is an increase in the theoretical volume, and the same with alloys. For this reason it would seem that the density of tan alloy would afford no basis for calculation. As a rule, the toughness of an alloy will be less than that of the metals which compose it; for instance a very small quantity of lead will suffice to reduce the toughness of gold, which in a pure state is one of the toughest of metals. In some few instances the alloy will be tougher than would be expected from its component parts; for instance, brass has greater tensile strength than copper, although the alloying metal, zinc, is one of the most brittle of all metals.

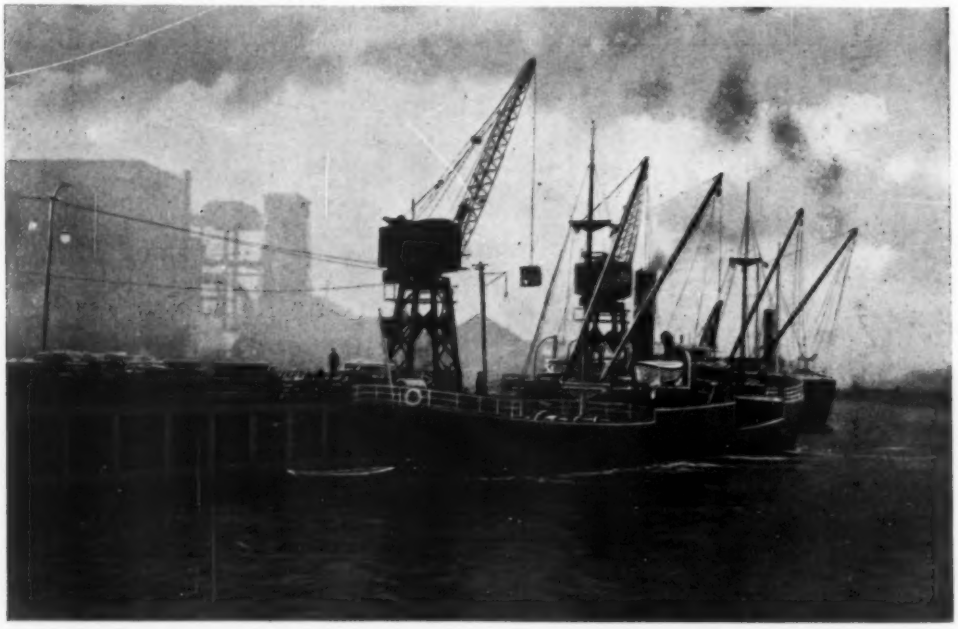


FIG. 3.—SHIPPING WHARF AT THE TEES IRON WORKS; MESSRS. WILSONS, PEASE & COMPANY, LIMITED.

Machine-Made Moulds for Casting Pipes on End.*

The cost of making sand moulds for cast-iron pipes amounts to about 45 per cent. of the total cost of production (leaving the metal out of consideration), and since the remaining 55 per cent. of the cost is distributed over a number of items, such as core-making, fettling the pipes, testing, varnishing, carriage, loading, and repairs to plant, etc., it is evident that the pipe-founder, in attempting to effect economies, must devote his attention mainly to reducing the cost of the moulds.

The most obvious course is to use permanent moulds made of steel, which will have such a long working life that the expense of replacement is reduced to a minimum. Many efforts have been made to carry this idea into effect—mostly in the case of light pipes, the small amount of heat given off by the thin walls rendering such pipes more suitable for casting in steel moulds. The chief difficulty attaching to these moulds, however, is that they distort or crack under the unequal heating to which they are subjected, and consequently are very short lived, in addition to which, the skin of the pipes is rendered too hard and dense by the sudden cooling, so that the pipes are hard to drill, and the asphalt varnish soon peels off, not having been properly absorbed into the pores of the metal. Finally, casting in steel moulds entails an increased percentage of silicon in the iron, in order to obtain a higher percentage of graphite and counteract the hardening tendency, the increased cost of the metal outweighing the saving in the cost of the moulds. Hence these moulds cannot be used for socket and flange pipes for gas, water, and steam, up to 300 lbs. pressure, and the founder is compelled to keep to sand moulds and see what can be done to reduce their cost.

With this object, some foundries employ special moulding boxes for pipes of all sizes, so that no more sand is used than is absolutely necessary. In the case of pipes over 20 in. in diameter the thickness of the sand is only about 1¼ in., and the moulder feeds the sand with one hand and rams it with the other. This does not seem advantageous, since with the thirty-three different sizes of cast pipe a very large number of costly moulding boxes are required, taking up a great deal of room, to say nothing of the defect of using only one hand for ramming, as it will take five or six men from 35 to 40 minutes to make a mould for a 26- to 32-in. pipe. Moreover, where the moulds consist of such thin layers of sand, the time required for drying is longer than with thicker layers, thus increasing the cost of drying and reducing the output to an extent more than outweighing the reduced cost of handling the sand.

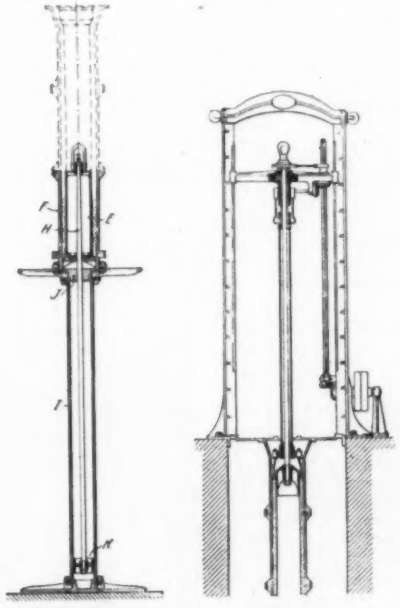


FIG. 1. FIG. 2.
COCHRANE & SLATE'S MACHINE.

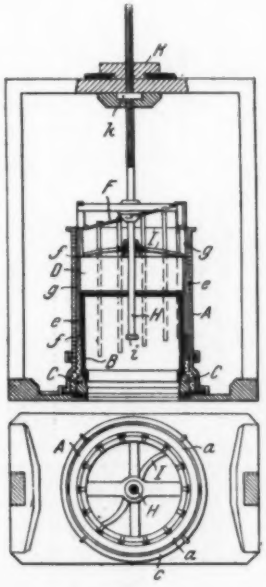


FIG. 3.
FULTON'S MACHINE.

Attention has also been turned to the substitution of machinery for hand labour in ramming the moulds, and the progress that has been made in this direction will now be dealt with, after a summary of the main points required in pipe moulds. The moulder's task is to compress the sand uniformly and so firmly that it will not give to any appreciable extent under the pressure of the molten iron. In the case of large, thick pipes, in which the metal at the bottom of the upright mould keeps fluid until the entire mould is full, the sand at the bottom of an 18-ft. mould has to stand a pressure of about 58 lbs. per square inch.

* R. Ardelt in "Stahl und Eisen."

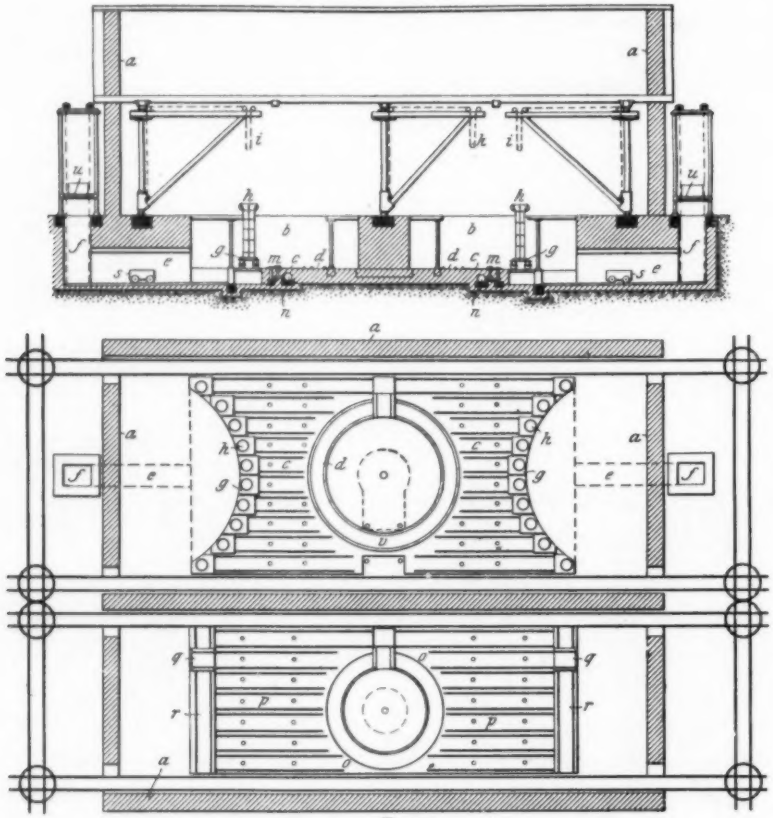
In most foundries the ramming of the sand in the upright moulds is performed by one to four men (according to the size of the mould) who shovel the sand into the space between the pattern and the box, whilst two to eight men ram it with rammers of suitable length, so that in any case a number of hands accustomed to work together are required, in order to turn out clean and satisfactory moulds. If among such a gang there is even one man less skilled than the others, the mould will be defective in some part, and the pipe will be imperfect. The work of ramming being of a highly inconvenient nature, owing to the hot, dusty air in which the work is performed, the men require high pay, and it is often difficult to find good mould-rammers at any price. In addition, this class of workers change their employment frequently, and are more often away, through indisposition, than other workmen. Consequently, the attempt to replace hand labour by machinery for this purpose is based not only on a desire to economise, but also to make the employer less dependent on his workmen, and at the same time to protect the health of those engaged in the work.

The machines or devices for ramming the moulds may be classified as follows:—(1) Machines which imitate the operations of ramming by hand, and are, therefore, the only type than can really be termed "pipe-mould ramming machines"; (2) machines which press the sand into the upright moulds by means of a worm or vane wheel; (3) devices in which the mould is drawn, the sand being pressed radially against the walls of the moulding box

Pipe-Mould Ramming Machines.

Cochrane and Slate, of Dudley, took out a patent in 1850 for the device illustrated in Figs. 1 and 2, the former being a section through the rammer. This device was fixed in an upright position, the mould box being placed on the top, as shown by the dotted lines. The comparatively short pattern E was kept truly centred by the guides I, J, K, and moved upward as the sand was rammed down by hand. This device un-

SECTIONAL ELEVATION.



PLAN.

FIG. 4.—PIPE FOUNDRY, ON THE DESLANDES SYSTEM.

doubtedly fulfilled the requirements of the period, especially for pipes of different lengths. The machine in Fig. 2 was for pipes of large diameter, and requires no special description. The mould box was attached to the lower end, and the pattern drawn up as the work progressed.

A machine of different type was that patented in 1851 by Samuel Fulton, of Conshohocken, Pa., U.S.A., and shown in Fig. 3. The moulding box was made up of clamped sections *a*, *a*, *c*, and after the socket had been rammed by hand, the pattern B, with its surrounding cylinder D, and the rammers *g*, were lowered into the box. By means of the threaded shaft H, the cylinder D was rotated and gradually raised, and the rammers were alternately lifted and allowed to fall by means of two inclined planes F. The sand was thrown in by hand, and distributed by

the vane I, and the rotary motion of the cylinder D helped to firm the sand. This machine, however, was no improvement on that of Cochrane and Slate, since the rammers always acted in the same place, and were prevented by the friction from exerting their full power.

An important advance was effected by Deslandes, of Manchester, in 1865, by the introduction of an entirely new method of casting pipes—a method that is still used in America, England, and Germany, and one that reduced the cost of production to a point not very remote from that in up-to-date foundries. Fig. 4 gives an elevation and plan of the foundry equipped on the Deslandes system. The outer walls are marked *a*, *a*, whilst *b*, *b*, are pits in the floor, traversed by longitudinal rail tracks *c*, and a circular

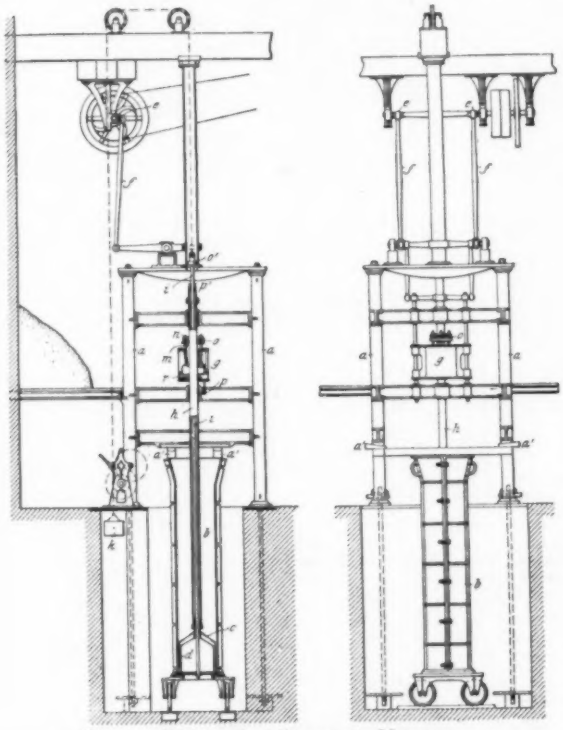


FIG. 5.—DESLANDES' RAMMING MACHINE.

track *d*. Tunnels *e*, and hoists *f*, *u*, connect the pits with the ground floor of the works. The pipe-mould boxes *h*, *h*, are moved about on the trucks *g*, *g*, and by means of the cranes *i*, *i*, and *k*, the middle crane serving the circular track *d*. After the moulds have been rammed at *v*, the boxes are run round the track *d*, and the moulds, being blacked with graphite, are moved by the crane *k*, on one of the tracks *c*, to be dried by standing over a hot-air pipe *m*. The cores are made in the core pit *o*, *o*, and when dry are conveyed along the tracks *p*, and the cross tracks *r*, into the moulding pit *b*, *b*, where they are inserted into the moulds by the cranes *i*, *i*, which also serve for holding the casting ladles. By using one pit for making the moulds, whilst the finished moulds in the other are being poured, the work is made continuous. The used sand in the emptied moulds is discharged into trucks *s*, and raised to the ground floor by the hoists *f*, *u*, to be mixed with fresh sand for use over again.

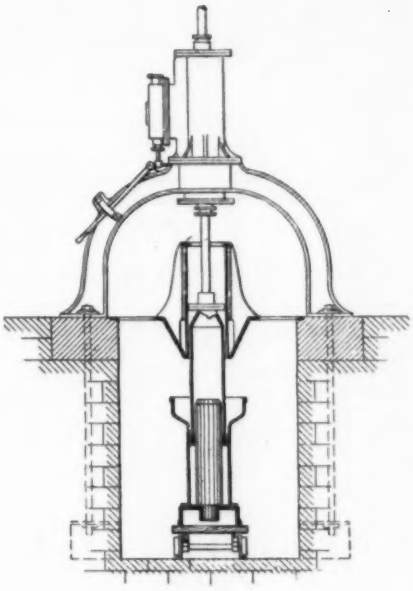


FIG. 6.—
SHEPHERD & LEIGH'S MACHINE.

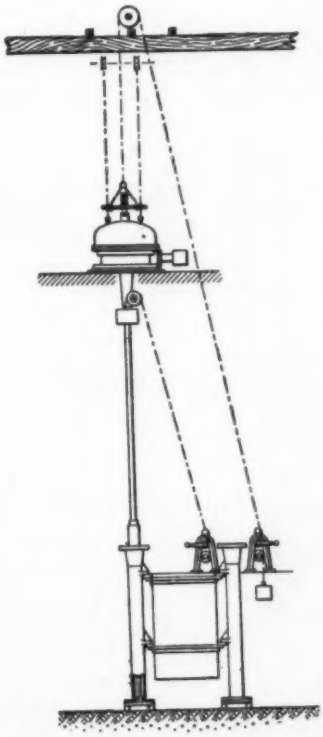


FIG. 7.—
SACK'S MACHINE.

The ramming machine is illustrated in Fig. 5, and is mounted on pillars *a*, *a*. The mould boxes are held in position under the machine by wedges a^1. The sand fed in through the top of the box falls on to the sloping cover of the hollow, cylindrical rammer *c*, and slides down between the box and the pattern, the latter, which is short (*d*), being counterbalanced by the weight *k*, and lifted by the buffer p^1, striking against the collar o^1, of the pattern rod *i*. The rammer is a cylindrical cap, loosely surrounding the pattern, and operated by a crank *e*, through the connecting rod *f*, and attached lever. The degree of pressure applied to the sand is regulated by a wedge *m* on the coupling *g*, the wedge slipping out of the coupling when a certain resistance is offered by the sand, the slipping point being varied by adjusting the nuts *o*. The descending rammer is rotated to increase the uniformity of the pressure by means of a ratchet and pawl *r*. When the pattern reaches the top of the box, the latter is released by knocking out the wedges a^1, a^1, and replaced by an empty box.

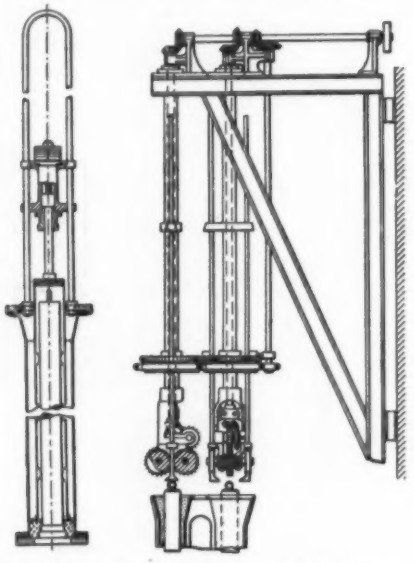


FIG. 8.—SACK'S PNEUMATIC MACHINE. FIG. 9.—GILES' MACHINE.

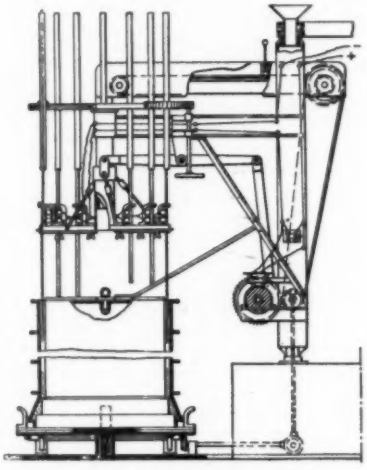


FIG. 10.—INGHAM, POULSON & MOORE'S MACHINE.

Other types of machine in which the rammers enclose the pattern after the manner of a bell are:—Fig. 6, that of J. Shepherd and T. B. Leigh; Fig. 7, that of H. Sack, Rath, Düsseldorf; Fig. 8, Sack's pneumatic mould rammer.

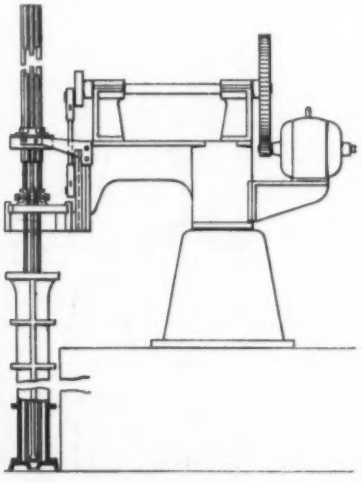


FIG. 11.—POULSON'S MACHINE.

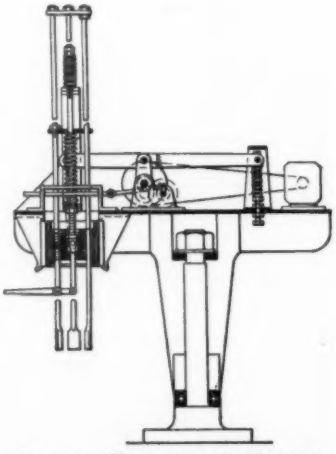


FIG. 12.—HEMSCHEIDT'S MACHINE.

The short pattern used in all the earlier machines entails considerable loss of time, and the rods have to be so thick that the machines cannot be built for making moulds below 10 in. in diameter. This defect was realised by the makers of the machines shown in Figs. 6 to 8, which use patterns the full length of

the mould, the tubular rammer being made somewhat longer than the pattern it surrounds. In the machines shown in Figs. 6 and 7 the rod operating the rammer must also be longer than the pattern, in order that the latter may not come in contact with the cross frame of the machine when lifted out of the mould box. Consequently, the shop has to be more than twice as high as the pipes cast, an inconvenience abolished by the machine in Fig. 8, in which the operating mechanism travels upward with the rammer as the work progresses, so that the height of the shop can be reduced. On the other hand, the long patterns used in the machines (Figs. 6 to 8) entail increased difficulty in feeding and distributing the sand in the boxes, and their output is no greater than those using short patterns, owing to the time wasted in manipulation and the difficulty of keeping the long pattern properly centred in the box when pipes of small diameter are being moulded.

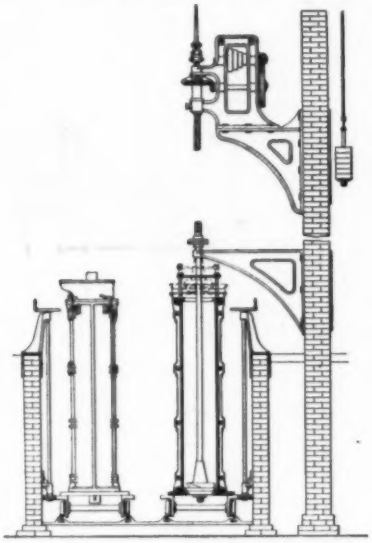


FIG. 13.—MILES & JOHN CORNTHWAITE'S MACHINE.

FIG. 14.—ROB. ARDELT'S MACHINE.

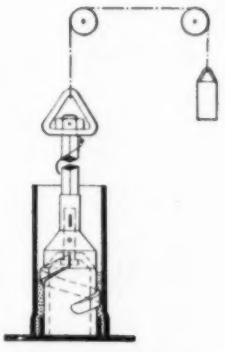


FIG. 15.—SCHALKER GRUBEN & HÜTTEN-VEREIN'S DEVICE.

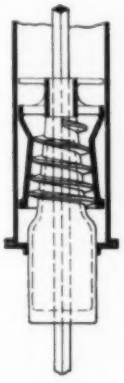


FIG. 16.—PAUL SCHRÖDER'S DEVICE.

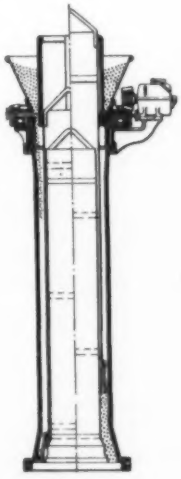


FIG. 17.—J. M. PIGNARRE'S MACHINE.

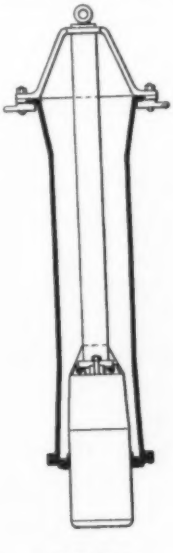


FIG. 18.—J. & C. CHAMBERS' DEVICE.

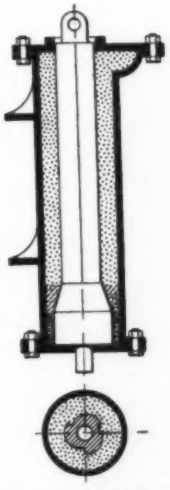


FIG. 19.—F. J. FRITZ'S DEVICE.

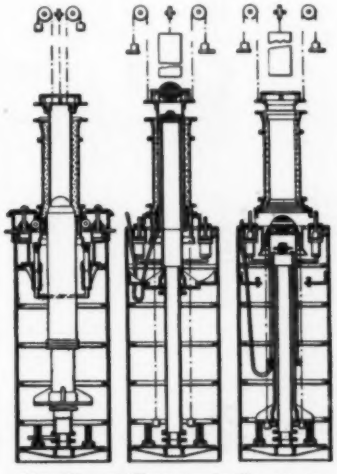


FIG. 20.—F. HERBERT'S MACHINE.

A separate type of machine is illustrated in Figs. 9 to 12, viz.:—David Giles' machine (Fig. 9); Ingham, Poulson & Moore's machine (Fig. 10); J. Poulson's

The ramming machine is illustrated in Fig. 5, and is mounted on pillars a, a. The mould boxes are held in position under the machine by wedges a^1. The sand fed in through the top of the box falls on to the sloping cover of the hollow, cylindrical rammer c, and slides down between the box and the pattern, the latter, which is short (d), being counterbalanced by the weight k, and lifted by the buffer p^1, striking against the collar o^1, of the pattern rod i. The rammer is a cylindrical cap, loosely surrounding the pattern, and operated by a crank e, through the connecting rod f, and attached lever. The degree of pressure applied to the sand is regulated by a wedge m on the coupling g, the wedge slipping out of the coupling when a certain resistance is offered by the sand, the slipping point being varied by adjusting the nuts o. The descending rammer is rotated to increase the uniformity of the pressure by means of a ratchet and pawl r. When the pattern reaches the top of the box, the latter is released by knocking out the wedges a^1, a^1, and replaced by an empty box.

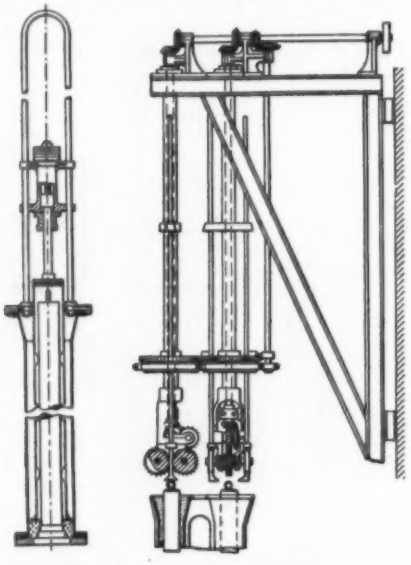


FIG. 8.—SACK'S PNEUMATIC MACHINE.

FIG. 9.—GILES' MACHINE.

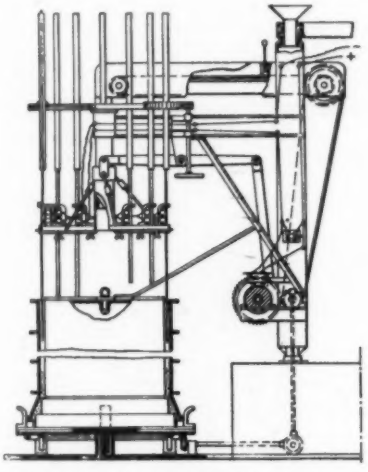


FIG. 10.—INGHAM, POULSON & MOORE'S MACHINE.

Other types of machine in which the rammers enclose the pattern after the manner of a bell are:—Fig. 6, that of J. Shepherd and T. B. Leigh; Fig. 7, that of H. Sack, Rath, Düsseldorf; Fig. 8, Sack's pneumatic mould rammer.

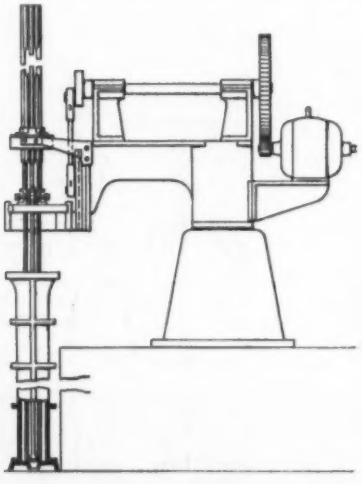


FIG. 11.—POULSON'S MACHINE.

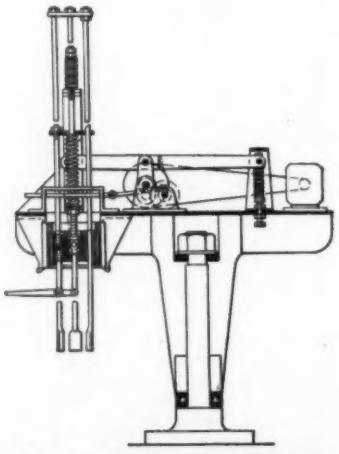


FIG. 12.—HEMSCHEIDT'S MACHINE.

The short pattern used in all the earlier machines entails considerable loss of time, and the rods have to be so thick that the machines cannot be built for making moulds below 10 in. in diameter. This defect was realised by the makers of the machines shown in Figs. 6 to 8, which use patterns the full length of

the mould, the tubular rammer being made somewhat longer than the pattern it surrounds. In the machines shown in Figs. 6 and 7 the rod operating the rammer must also be longer than the pattern, in order that the latter may not come in contact with the cross frame of the machine when lifted out of the mould box. Consequently, the shop has to be more than twice as high as the pipes cast, an inconvenience abolished by the machine in Fig. 8, in which the operating mechanism travels upward with the rammer as the work progresses, so that the height of the shop can be reduced. On the other hand, the long patterns used in the machines (Figs. 6 to 8) entail increased difficulty in feeding and distributing the sand in the boxes, and their output is no greater than those using short patterns, owing to the time wasted in manipulation and the difficulty of keeping the long pattern properly centred in the box when pipes of small diameter are being moulded.

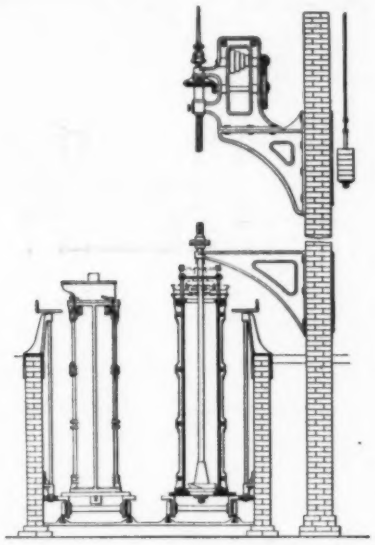


FIG. 13.—MILES & JOHN CORNTHWAITE'S MACHINE.

FIG. 14.—ROB. ARDELT'S MACHINE.

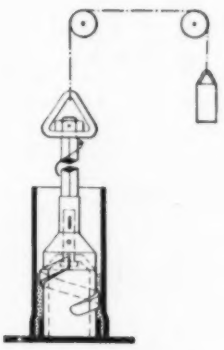


FIG. 15.—SCHALKER GRUBEN & HÜTTEN-VEREIN'S DEVICE.

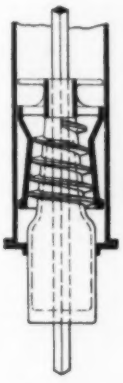


FIG. 16.—PAUL SCHRÖDER'S DEVICE.

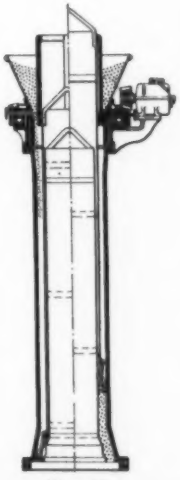


FIG. 17.—J. M. PIGNARRE'S MACHINE.

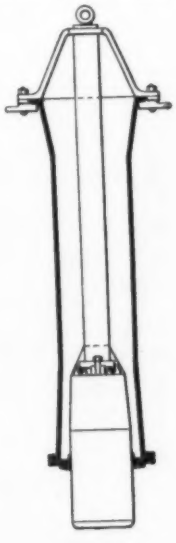


FIG. 18.—J. & C. CHAMBERS' DEVICE.

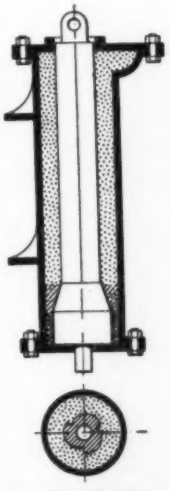


FIG. 19.—F. J. FRITZ'S DEVICE.

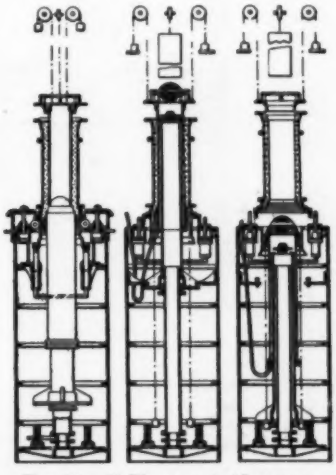
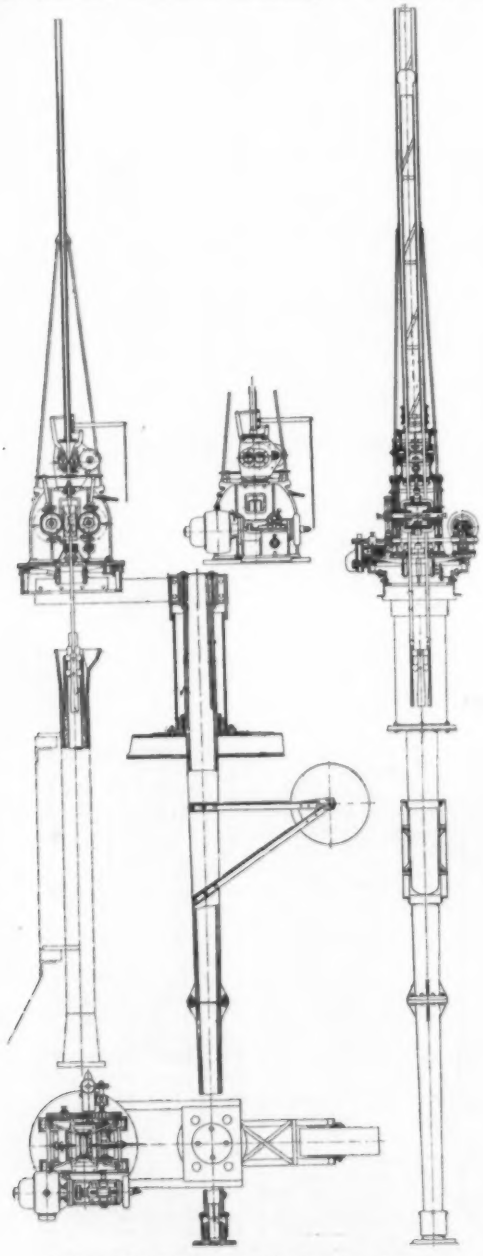


FIG. 20.—F. HERBERT'S MACHINE.

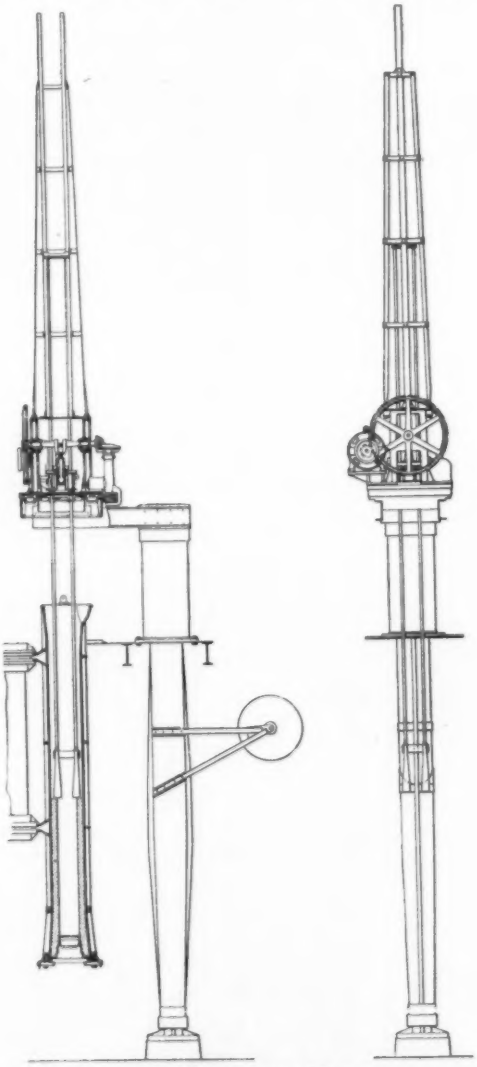
A separate type of machine is illustrated in Figs. 9 to 12, viz.:—David Giles' machine (Fig. 9); Ingham, Poulson & Moore's machine (Fig. 10); J. Poulson's

machine (Fig. 11); and H. Hemscheidt's machine (Fig. 12). All these machines employ patterns that must be at least as long as the mould to be produced. The rammer, instead of consisting of a number of single rammers combined to form a rigid system, as in the machines already described, is made up of a number of separately operated rammers.



FIGS. 23 & 24.—ARDELT'S MACHINE WITH FREE-FALL RAMMER.

In the same way that each man uses one rammer in hand ramming, the idea in these machine is to operate each rammer separately. The special operating rod is abolished, each rammer being gripped direct by the driving mechanism of the machine and moved up and down by same. This system obviates many of the defects of the previous machines, but is in turn attended by the drawback that the individual rammers are deficient in rigidity, owing to the small diameter in relation to their length. It is essential that the sand be uniformly distributed by the ends of the rammers, and to secure this result the rammers must be caused to travel round the pattern, or else (as shown in Fig. 10) the moulding box and pattern must be rotated round the rammers. In view of the low rigidity of the latter, this movement of rotation is necessarily very slow; but as on this movement depends the capacity of the machine, the rapid working indispensable if the machine is to equal or surpass hand ramming is impossible.



FIGS. 25 & 26.—ARDELT'S MACHINE WITH POSITIVE DRIVE.

FIG. 21.—ARDELT'S RAMMERS.

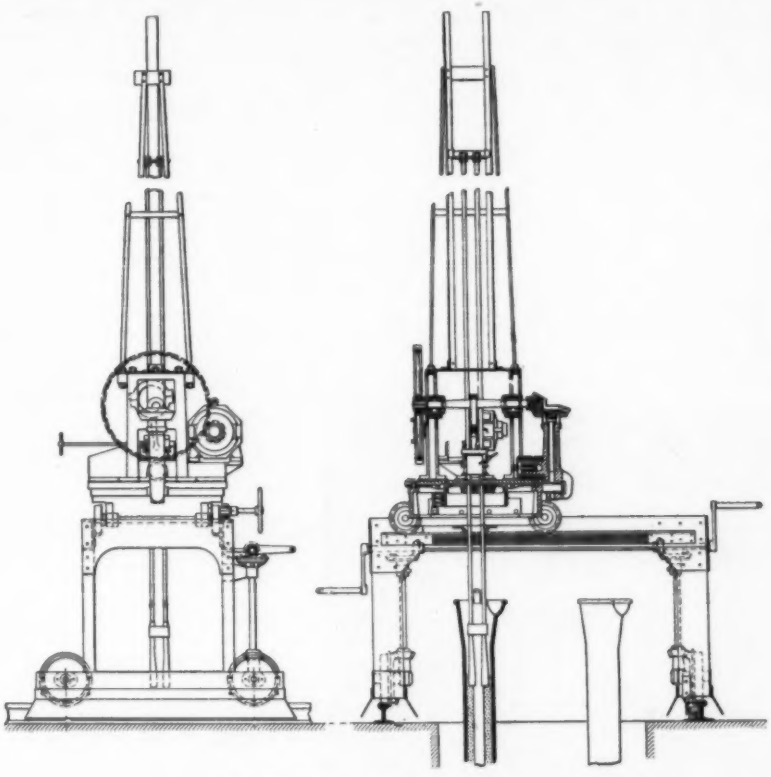


FIG. 27.—ARDELT'S PORTABLE MACHINE.

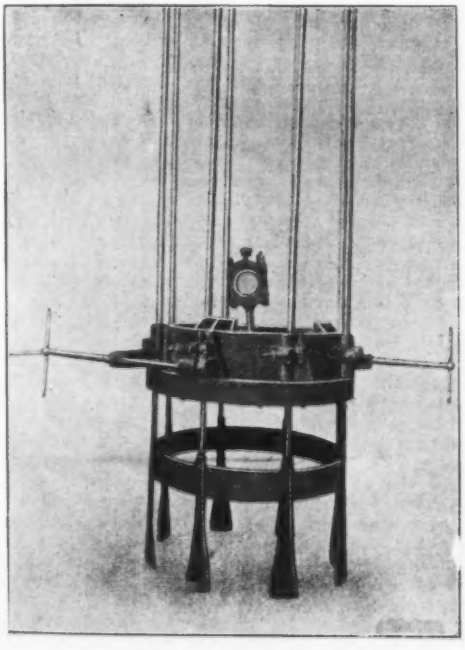


FIG. 22.—ARDELT'S RAMMERS.

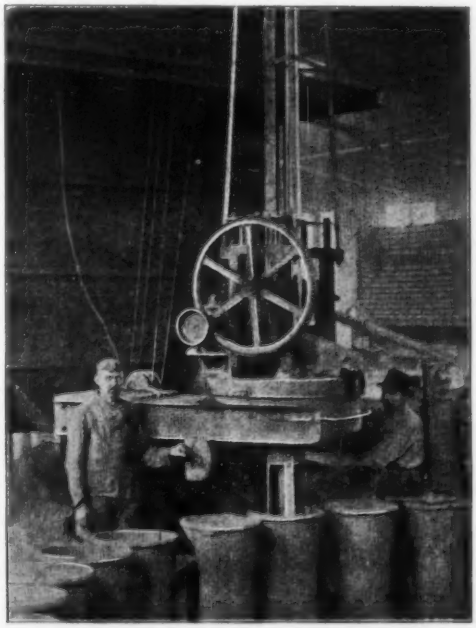


FIG. 28.—ARDELT'S MACHINE WITH POSITIVE DRIVE, RAMMING MOULDS FOR SOCKET PIPES.

Worm Device

Figs. 13 to 17 illustrate a number of devices and machines for making pipe moulds by the aid of a worm or vane wheel, Fig. 13 being the machine of Miles and John Cornthwaite, Fig. 14 that of R. Ardelt, Fig. 15 that of the Schalker Gruben- & Hüttenverein, A.G., Fig. 16 that of Paul Schröder, and Fig. 17 that of J. M. Pignarre. Most of these devices and machines have the drawback that the socket mould at the bottom has to be rammed by hand, thus losing a good deal of time, and that the wear of the parts in friction is heavy. At the same time, the friction of the rotating parts in the moulding sand consumes a large amount of motive power, and finally a separate moulding device is required for each size pipe, so that much time is wasted when the size of pipe has to be changed.

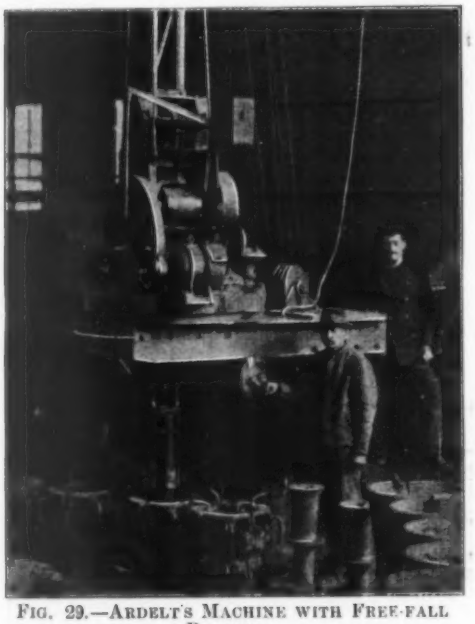


FIG. 29.—ARDELT'S MACHINE WITH FREE-FALL RAMMERS.

It is probable that moulds for pipes of small diameter and of usual length could not be made with the machines shown in Figs. 13, 14, and 16; whilst it would be difficult to make them for pipes of large diameter with those of Figs. 15 and 17, apart from the high consumption of power involved.

Draw Patterns.

A number of attempts have been made at forming the moulds in the simplest manner, namely, by drawing a short pattern (tapered at the upper end) through the box, after the latter has been filled with sand. The machines resulting from these attempts are illustrated in Figs. 18 to 20, Fig. 18 showing that of J. & C. Chambers, Fig. 19 that of F. J. Fritz, and Fig. 20 that of F. Herbert. In making moulds with these draw patterns, the mould box is filled with a suitable quantity of sand, the pattern, which is of the same dimensions as the external diameter of the pipe, being then drawn or pushed through the box. In the Fritz device the pattern is rotated about its longitudinal axis, both before and during the operation of drawing, in order that the sand may be compressed between the pressing pads on the pattern rod and the walls of the box. It is evident that considerable force is required to pull the pattern through, and consequently the box must be very strongly made, and the cranes and building be of very powerful construction.

The Herbert machine is independent of the strength of the crane and building, the pattern being forced through the box by a plunger operated by hydraulic or other suitable power. This, however, necessitates fixing the machine, and the mould boxes must be transported—a condition that is not suitable for all foundries, and is also too costly to be recommended. Fixing is difficult with large boxes, and the operation of the device takes up too much time, it being necessary to ram the socket moulds in most cases. The pattern is also subjected to heavy wear, owing to the high superficial pressure under which the pattern is drawn through the sand.

None of the machines hitherto described is so perfect as to have made general headway in practice. Most pipe founders fight shy of them, in most cases on account of their low capacity, there being no advantage in comparison with hand ramming, whilst in other cases the manipulation of the mechanical devices takes up too much time. Other devices, again, necessitate the use of mould boxes of special arrangement and construction, and are dependent on the construction of the foundry, or else can only be used for pipes of certain sizes. One of the greatest disadvantages, however, is the heavy wear of the devices and the high motive power required to operate them.

The machine devised by the author is believed to meet all the requirements demanded of such machines; and this view is confirmed by the rapidity with which it has made headway in various countries. In the case of this machine, the initially strong prejudice of the workmen against ramming machines soon disappeared wherever it has been introduced; and instead of doing their utmost to treat the machine badly they now endeavour to keep it in the best possible condition, having recognised its value, so that now the cost of repairs is scarcely higher than the upkeep of hand rammers. The great advantage of the machine is in the ease and quickness with which it can be handled and the reliable manner in which it operates. The relatively high peripheral velocity and special construction of the rammers enable the sand to be distributed quickly and uniformly; in fact, the high velocity of the rammers causes the greater portion of the sand to collect below them even before the actual down-stroke.

Fig. 21 shows this machine with two and eight rammers, the former being intended for a free-fall apparatus, and the other for machines in which the rammers are operated by a clutch, as shown in Fig. 22. The number of the rammers depends on the size of the machine. Figs. 23 and 24 illustrate machines with free-fall rammers, the mould boxes being placed on a rotary table; whilst Figs. 25 and 26 represent the same machines with positively operated rammers. If the mould boxes are arranged in rows, the machine is portable, arranged on a trestle frame, as shown in Fig. 27. If the mould boxes are to be mounted on trucks for ramming, the machine is fixed on four pillars. Consequently, all the contingencies occurring in pipe foundries are provided for, the only precaution required being that the thickness of the sand layer in the mould should not be too low, since this would mean using stamps of insufficient strength. The minimum thickness recommended for the sand is 1½ in. The number of strokes per minute varies between 120 and 160, and the lifting mechanism is driven by a 1½ h.p. electromotor in the small machines, 6 h.p. being required for the largest sizes.

The time occupied in ramming a mould, from start to finish is:

Diameter in inches.	Length in feet.	Time.
1½-2½ ...	10 ...	1 minute 15 seconds
2½-3½ ...	11½ ...	1 ,, 20 ,,
3-3½ ...	11½ ...	1 ,, 25 ,,
5-6 ...	13 ...	1 ,, 45 ,,
6½-8½ ...	13 ...	1 ,, 55 ,,
9½-11½ ...	13 ...	2 minutes 5 ,,
12½-14½ ...	13 ...	2 ,, 15 ,,
15½-19½ ...	13 ...	2 ,, 30 ,,
21½-25½ ...	16½ ...	3 ,,
27½-31½ ...	16½ ...	4 ,,
35½-39½ ...	16 ...	5 ,,
43½-47½ ...	16 ...	6 ,,

The number of men required for working the machine is one man for feeding the sand into the smallest moulds and six men for the largest. The socket mould at the bottom is also rammed by the aid of the machine, the rammers being made flexible for this purpose, so that they can spring apart and act outside the thicker socket pattern.

Figs. 28 and 29 show the newest machines in use at the Lauchammer Works at Gröditzfor, making flange and socket pipe moulds. At this foundry the mould boxes are fixed on large, electrically operated turntables, the ramming machine being mounted on a swing jib, so that the machine can be quickly and accurately centered over the mould box and the pattern therein, by moving the jib and turntable. When this has been done, the rammer is lowered into the mould box, at a speed that can be regulated at will, and the machine can then be started. As soon as ramming is finished, the machine is swung on one side, to make way for the hook of the pattern winch that is mounted exactly over the centre of the mould box. The pattern is drawn out and transferred to the next empty box, whereupon the whole series of operations is repeated. At other parts of the turntable the moulds are blacked, dried, fitted with the cores and poured, the finished pipes being finally drawn, so that the work is practically continuous.

The Effect of Superheated Steam on Cast Iron and Steel.

In our issue of February last we published abstracts of three Papers by Professor I. N. Hollis, Professor E. F. Miller, and Mr. A. S. Mann respectively, on this subject, read before the American Society of Mechanical Engineers. Further contributions to the discussion of this subject, published in the Journal of that Society, show that very divergent views are held on the matter by different men. We present herewith extracts of some of the contributions:—

George A. Orrok.—When we first considered the use of superheated steam in our power stations a few years ago there had been developed a type of steam piping which most engineers considered excellent. The piping itself was of steel with Van Stone flanges, the flanges being of sufficient thickness to prevent buckling. The fittings were all cast iron of a carefully worked-out pattern, much stronger than the ordinary high-pressure fittings. The valves were of similar design, and the whole piping system was bolted together with steel bolts of larger size and greater number than the ordinary extra heavy standard required. This piping system gave absolutely no trouble with saturated steam. The up-keep of such a system under power station conditions with 200 lbs. steam pressure over a period of a number of years was almost nothing. Superheated steam, however, introduced another factor, and a very important one. From certain tests made it was considered that this superheat might vary over a range of more than 200 degrees, and the temperature strains brought upon the piping and the valves would be severe. It was finally determined to make the entire pipe line of steel. We adhered to the steel piping with the Van Stone joint, but made the Van Stone flange of cast steel from the cast-iron pattern. The steel fittings were not as heavy as cast-iron ones of the same size, but differed considerably in the detail of design. The steel valves followed the design of the fittings and were of various makes, both single and double wedge. Our experience with the steel valves has been good, and we feel that they are giving better satisfaction than was to be expected under the circumstances. Troubles developed from blowholes, however, which led to an investigation of the subject about a year and a-half ago. We traced most of the blowhole difficulties to improper moulding, improper gating and to over-oxidised metal in the case of Bessemer steel and cold metal in the case of open-hearth steel. The valves and fittings are about equally divided between Bessemer and open-hearth steel, all of the former being made, however, on the baby convertor by the Tropenas and Zenzes process. The manufacturers understand better to-day how to handle the work, and the castings which we are receiving are much better than they were two or three years ago.

I had occasion to look up a number of power stations in which cast-iron fittings and valves had been installed for use with superheated steam. In one of these stations I saw fittings which had been under the action of superheat for approximately nine months and had been removed because of the many leaks which had developed. The castings were supposed to have been made from the best air-furnace iron, but were swollen and bulged practically all over, the outside being covered with fine hair cracks. None of the castings had gone to pieces, but practically all had developed leaks, and were being replaced with steel. At another station a cast-iron valve had gone to pieces, and many other valves and fittings had been seriously affected. There were a number of vertical engines in this station in which superheated steam had been used. All the high-pressure cylinders had cracked in two or three places, and they were replacing the cylinders and had so arranged their pipe line that no more superheated steam could get to them. The fittings which I examined, taken from the superheat line, had all undergone a growth in size, and the outside was covered with fine hair cracks and seemed very much swollen. Analyses of the metal showed a silicon content of from 1.88 per cent. to 2.33 per cent., phosphorus about 0.7 of 1 per cent., low manganese and almost no combined carbon. The tensile strength of the material after its exposure to superheat was, in the case of the iron with the silicon content of 1.88 per cent., about 4,500 lbs. per square inch; in the case of the silicon content of 2.33 per cent. it averaged about 8,500 lbs. per square inch. We have no means of knowing what this was when it was first made. Microphotographs of the etched surfaces of this metal show the

essentially open character of the iron. In this particular station the superheaters have been removed and their troubles have ceased.

Referring to air-furnace iron, or gun-iron as it has been called, I think the great difficulty is the fact that it is almost impossible to control the regular composition of the product. The reverberatory furnace, while a comparatively simple piece of apparatus, is remarkably delicate, and uniform results are obtained only when the very best of care is taken. It is a comparatively easy thing to refine high silicon iron to some kind of refined iron, but it is a much harder thing to get a uniform result from each heat.

W. K. Mitchell.—The following notes are taken from several years' personal experience with superheated steam and its effect on cast-iron valves, fittings, etc. :—Our first intimation that cast-iron fittings and valves gave trouble under superheated steam conditions occured about three years ago, and came in the nature of a surprise, as we had been using superheated steam for some years previous. The first case was in a railway power plant for a high-speed electric line. The plant had been running for several months under a fairly constant load, but owing to a falling off in traffic it was decided to cut down the service to one-half or less, which made the load quite variable. Three months after this had been done the trouble with the fittings and valves began to develop. It was first found that the valves could not be closed tight, and gaskets were giving trouble. Then fittings began to show signs of weakness, cracks appearing on the outer surface. Fortunately these cracks never extended through. In an 8-in. by 6-in. double tee, the metal of which was about $\frac{3}{4}$ in. thick, the cracks did not extend more than half-way through, which would indicate that there is no advantage in very thick castings under such conditions. The most serious of these cracks occurred at the junction of the flange and fittings, and kept growing to so alarming an extent that several fittings were replaced. It was then noticed that the old fittings had lengthened considerably. The original length of some 8-in. by 6 in. double-tee fittings was 35 in., and when taken out and cooled they measured 35$\frac{1}{8}$ in. to 35$\frac{3}{4}$ in. They had been in service about nine months. Open-hearth cast-steel fittings and valves were substituted for those of cast-iron materials, and have been working satisfactorily ever since. The railway plant was designed for a steam pressure of 175 lbs. per square inch, and superheat was intended to be 150 degrees F. That this temperature had been greatly exceeded, however, was made evident by the discovery of a board that had been charred by contact with the steam trap which rested on it. The president of the company that installed the superheaters said that while they were built to give an average of 150 degrees superheat, "the real question was not one of the amount of superheat, but of velocity." This seems reasonable when one considers that if the load should fall very low, the velocity of the steam through the superheaters would be considerably reduced and its temperature correspondingly raised. Again, a sudden increase in the demand for steam would result in a rapid flow through the superheater, and steam at much lower temperature, and these recurring changes of temperature must necessarily cause rapid changes in the lines due to expansion and contraction. We therefore concluded that in this particular plant, at least, the damage to the fittings and valves was not caused by the high temperature itself, but by the constantly changing temperatures due to the change of load. Our contention that the damage was due to variable temperatures seemed to be borne out by the fact that in a cotton mill plant installed three years previously, where the steam requirements for pressure and superheat were higher than those mentioned (the pressure being 200 lbs. per square inch, and superheat 200 to 250 degrees F.), the fittings and valves were of regular cast-iron, and there had been no trouble to speak of. The load was practically constant, however, varying not more than 15 per cent. at any time.

On account of the discussion during 1908 regarding the disastrous effects of superheat on cast iron, the owners of the mill grew anxious about their piping and asked the writer to look over the system. He found everything normal; the fittings were tight, valves could be operated freely, and in a general way the plant was in good condition. The first installation had been made in 1903, and a second one in 1906, using the same class of fittings and valves. The writer suggested that measurements be taken of all the fittings and valves in the plant and records kept of changes. The original dimensions were determined as closely as possible from the patterns and records of construction, and beginning with July, 1908, records were kept of the dimensions of the fittings for a period of nine months. Although the changes in the dimensions were slight, the increase in length of certain of the fittings was such that it was thought unsafe to continue them in use, and steel fittings were substituted throughout. Most of the valves, however, are still in service, and there have been no failures in either fittings or valves. The facts seem to show that even at high steam temperatures, if cast iron can be kept at a uniform temperature and not cooled off too frequently or too rapidly, it will meet the requirements of superheated steam for a long period; but if the temperature is subject to frequent changes such as occurred in the railway plant, the cast iron will become disintegrated and ultimately fail within a short period of time.

It is my opinion that in plants where the load is constant and the temperature of the steam therefore constant, properly designed piping with cast-iron fittings of good material will do the work satisfactorily and be safe for a long time. I believe there is no advantage in using cast-iron alloys known as semi-steel, ferro-steel or gun iron. In the railway plant first referred to, the fittings were of cast iron from one foundry; gate valves of semi-steel from another; and stop, check and emergency stop valves also of semi-steel from a third. The results in each case were practically the same.

While open-hearth steel castings seem to be successfully used under superheated steam conditions, I do not believe they will last indefinitely because of their extreme thickness. There must be changes taking place similar to those in cast iron, due to temperature changes, but the ductility of open-hearth steel will, undoubtedly, delay the process of disintegration for a longer period. The material which we recommend and use to-day for high-pressure superheated steam, is wrought steel throughout, with welded nozzles instead of fittings, and steel flanges, using bends in all cases in preference to short elbows.

(To be continued.)

Progress is being made with the preparations for the Naval, Mercantile Marine and General Engineering and Machinery Exhibition to be held at Olympia, London, W., from September 1 to 26 next. The Exhibition, indeed, will very largely reflect the strides that have been made in engineering science during the past three years, and many of the latest inventions will be on view for the first time.

Business Methods for the Ironfounder.

Wages and Bonus Systems.

By Percival P. Richards, A.C.A.

(NOTE.—The Editor has arranged for questions arising out of this article to be dealt with by the author, who will be pleased to assist any readers who require further information on the subject treated. Queries should be addressed to the Editor of the FOUNDRY TRADE JOURNAL, as early as possible, if replies are desired in the next issue.)

The first article under this heading dealt with the subject of cost finding, and the question of wages was only briefly dealt with. It is now proposed to consider the subject more fully, tracing the records from their source.

Wages.

The wages cost is one of the heaviest items of expense, and a bad system of recording time, or a slack system of making up, may soon lead to considerable loss, which may pass unnoticed for a lengthy period unless some unusual combination of circumstances arises to disclose the leakage. It, therefore, behoves the manufacturer to see that he only pays for work of which he is getting the benefit, and that, having paid for it, the charge is carried to its correct destination in the system of accounts and costings.

Intermediate records should, as far as possible, be abolished, in order to minimise errors and to save time, as there is usually little time to spare between the end of the working week and the time for payment of money to the workman.

The first point to consider is the checking of the men in and out, morning, evening, and at meal times. The old method is to do this by means of a gatekeeper, possibly with the assistance of tallies or numbered discs, which the workmen deposit on entering. This method always leaves the probability of small errors of odd minutes, and if the gatekeeper is lax it may lead to substantial losses. When the annual wages bill is a large one this lost time totals up to an appreciable sum at the end of the year. It may often happen that a gang of men will be kept waiting for one late individual, and the output of the foundry suffers accordingly. In order to detect and stop this lost time, a mechanical recorder of times in and out should be installed. A wages clock recorder will show accurately to the half-minute when each man registered his time, and a glance down the weekly records will show up defects which would pass unnoticed under a gatekeeper. It is an advantage to have a record in which the late times are shown up in a different colour and overtime also shown distinctly. Clocks can be obtained to do this, The men's time in and out can be recorded either on cards, one for each man, or on sheets, one sheet per week, showing all the time of each workman for the whole week. On some machines two records may be obtained, one on the sheet and one on a card.

All the time clerk has to do is to see that each man only "clocks on" for himself, thus leaving the clerk free to attend to other matters during a large portion of the day. At the week-end the sheet record is removed from the clock and the total time for each man ascertained. The rates are then filled in and the total wage per man calculated. No copying or transferring of records is necessary, much time is saved, and greater accuracy of records obtained. The wages should be paid from tins at the time-clerk's office. They should never be taken round during working hours, as this causes the men to slack off sooner than they should. All hands, whether paid on time- or piece-work rates, should be "put on the clock," in order to ensure their keeping good time and thus getting full production in the foundry. If a piece-worker is late the foundry loses production.

The time sheet from the clock, together with the list of men on piece-work rates, foremen, and men on weekly wages will give all the figures necessary for the payment of wages, without any further copying

The numbers of the men should be arranged so as to group the different departments and classes of work.

In order to carry any useful costings system into effect it is necessary, in addition to the wages record just mentioned, to know the exact time spent by a time-worker on each job, and, here again, the mechanical record should be adopted. If it is left to the men to record the details of their time under job numbers on time sheets, the results obtained can only be approximate, and a foreman's check on these records is usually slack. So long as the record looks all right, and the total time worked is accounted for, the foreman will not often trouble himself further. The result is that a workman can manipulate his record, and if he takes too long on a small job he may add the excess time on to a large job, where it is difficult to detect the discrepancy. This may tend to "slacking" on the part of some men, and will lead to inaccurate cost records. In order to remedy this, time clocks should again be brought into use. The cost clerk, time clerk, or foreman—according to the size of the foundry—should hand out to each time-worker a card for every job upon which the man works, and before commencing the job, the workman should be required to record on the card, by means of the time clock, the time at which his portion of the work was started.

It is advisable that the clock be placed in a position where it is easily accessible from all parts of the shop. It should be near the foreman's office in order that he may see that no time is wasted in going to and from the clock. Some managers prefer the cost clerk to record the times on the cards instead of allowing the men to go to and fro in the shop. When a man has completed his part of a job the card is stamped with the time and then handed into the foreman's office. This system will prevent manipulation of time records on jobs and will enable the shop manager to ascertain whether too much time has been spent on any job, and if so which workmen are responsible for the loss.

At the week end the total of each man's time on the job cards is agreed with the total time worked according to the wages sheet, and the job times are priced out and transferred to the master cost cards. In order to prevent confusion different coloured cards may be used for each shop or each process. When this system is adopted a simple form of wages sheet can be arranged which will give without extra clerical labour the total wages payable to each man, the total wages per week chargeable to each job number, and the total wages paid in each shop. Also when the sales are divided departmentally in order to obtain separate departmental manufacturing accounts, the

wages sheet can be arranged to show—in addition to the above information—the total weekly wages chargeable to each department under the various headings, and this without any material alteration of the job card system. In practice a wages system giving all this information will be found to be invaluable to the management.

The system will also bring all defective castings to light owing to the time taken to produce the perfect casting, as the record will show double time on the job. Bad workmen will thus be discovered and can, when necessary, be weeded out, and the knowledge of this will tend to better work all round.

The total time occupied should, on the completion of each job, be scrutinised by the shop manager, and when the order is a repeat or a stock line the time should be compared with that occupied on previous occasions. This will tend to a larger shop production if the manager is efficient, as it will enable him to keep all his men up to the required speed. It should always be borne in mind that the greater the production in a given time the lower will be the trading or on-cost charges during that time.

Bonuses.

Much discussion has taken place recently in regard to bonus systems for workers. The "Premium Time" method still has many adherents, and in some cases is found to work well. When this system is in use its success depends to a great extent on the ability of the shop manager in fixing the times allowed for different jobs. Under a good man both worker and management will benefit. The worker knowing that he can by his own energy earn more money will usually do his best if the basis is equitable, and the management will not only get an increased production, but will also be able to promise quicker delivery and to keep promises when made.

This method, however, only ensures "speeding up"; there is no inducement to economical working, and a system which will combine the two is the one which should be adopted when it is desired to make a change in this direction. In order to obtain economical working it is necessary to interest the foreman by making him responsible for the output of his department, and also, what is more important, for the working expenses. This can be done by offering a bonus on the saving effected by reduced working costs, the annual trading accounts being taken as the basis. It is not necessary that the figures should be disclosed to the men, and in most cases it is not desirable; but arrangements can easily be made to overcome this difficulty. If a foreman cannot earn a bonus under such an arrangement, then either the system is not equitable or the man is not efficient. If the former, the system must be altered; if the latter, then it is time to consider whether a new man could not do better. A good foreman, if offered a reasonable inducement to take an intelligent interest in his department, can generally give valuable assistance in reducing working costs, and if the men are co-operating with him (for a consideration) in trying to increase production, then the employer will also get a corresponding benefit in increased profits. Another important advantage is the feeling of goodwill between the employer and the employed which will be fostered under such a system as this. The fixing of rates at the commencement will be a matter requiring much tact, but after a basis has been arranged a short trial will show up the defects which can then be remedied.

In the case of workers paid on the tonnage basis—for example, breakers, loaders, pourers, etc.—the premium should be paid on the weekly tonnage produced in excess of a fixed figure of production, which figure may be varied according to the nature of the castings produced during the period.

When possible, labourers should be put on the same basis as the moulders they are assisting, but general yard labourers should be remunerated under the system on the basis of the weekly tonnage output. Any system which is to be of practical value must of necessity be specially adapted to the local requirements and conditions, but the principle can be arranged so as to include almost all the workmen in the foundry on the basis that each one, whatever his work, is required to assist in making some saving either in time or material or in increased production, and having done so, he is entitled to share in the saving made.

Sometimes a sliding scale is adopted, so that the greater the saving made the greater will be the percentage of the saving which is allocated to the workman in the form of extra wages. For instance, if a time of 20 hours is allotted to a moulder for a certain job, and he does it in 16 hours, there is a saving of four hours, or 20 per cent. of the total time allowed. Under the sliding scale the moulder would be allotted 20 per cent. of the actual wage cost as additional pay. If he is paid 1s. per hour, then he is allotted 20 per cent. of 16s., or 3s. 2d. If he does the job in 15 hours, then as the saving is five hours, or 25 per cent. of the time allotted, he is paid 25 per cent. of 15s. (the actual wage), which is 3s. 9d. Except in very extreme cases this system is to the advantage of the worker, and is a better one than the fixed percentage basis. Under the premium system neither the employer nor the employed stand to lose anything, as both share in the additional profit resulting from the increased production; the employer will find his wages cost percentage reduced, and the workman will receive higher wages for working the same time as before. If no saving is made, then the workmen still receive their old rate of wages and the employer still obtains the same return for his outlay. The chief point is to interest the men in the scheme and to explain it to them clearly and concisely, so that they may thoroughly understand the working of it. Once the idea is grasped and the men interested their co-operation is generally assured to the benefit of all concerned.

The Local Government Board have issued a circular to clerks of Parish Councils which states that the Board think it desirable to draw attention to Section 7 of the Trade Boards Act, 1909, which provides that no contract involving employment, to which a minimum rate fixed under that Act is applicable, shall be given by a local authority to any employer unless he has given notice to the Trade Board, by whom that rate has been fixed, that he is willing that the rate should be obligatory on him.

Arrangements are now being made for the Sheffield meetings of the British Association next month. The headquarters of the Association will be at the Cutlers' Hall, and all the twelve sectional meetings will be within very easy distance. The sections will be housed as follows:—Mathematical and Physical Science Section, Montgomery Hall; Chemistry, Channing Hall; Agriculture, Surrey Street Music Hall; Geology, Victoria Hall; Zoology, Friends' Meeting House, Hartshead; Geography, Old Firth College; Economic Science, Builders' Exchange; Engineering, Carver Street School; Anthropology, Central Secondary School; Physiology, The University; Botany, Masonic Hall; Educational Science, Nether School. The meetings open on Wednesday, August 31, at 12 o'clock noon. On Thursday morning, at 10 o'clock, all the sections will get to work, and will sit daily until the following Wednesday. In addition to various excursions, arrangements have been made for visits to about 20 representative works in Sheffield.

The Corners on Castings.

By Walter J. May.

In dealing with granular metal, such as cast iron and some of the zinc alloys, the arrangement of the grains or crystals of the metal should be taken into some consideration, and from a general point of view it will be found that these arrange themselves better in curved than in angular spaces in the moulds. Roughly, in the cross-section of a square bar they appear as in Fig. 1, and in extreme cases the angles of such a bar would break off very easily with a light blow from a hammer or other hard object. Taking, for instance, a cylinder cover, it will be found that the edges are liable to chip off more readily than a piece

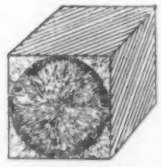


FIG. 1.

FIG. 2.

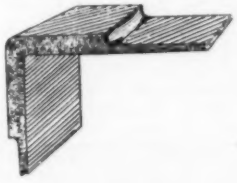


FIG. 3.

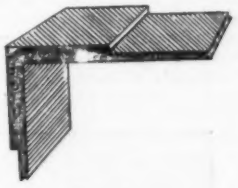


FIG. 4.

can be chipped off the metal, supposing the cover to be broken in halves; or, in the case of the frame of a machine, the cast edges are more readily damaged than any other part. Of course, a square-edged casting looks best in either case, but most cylinder covers may very well be cast with a rounded edge, as shown in Fig. 2, and be afterwards turned down, while with machine frames and the like they may very well be cast with a rounded edge and inside fillet, as shown in Fig. 3, instead of being cast square, as in Fig. 4; for in the last example, not only is the casting less strong, but unless the sharp edges are to some extent chamfered or rounded off, they are likely to cause injuries to persons working against them. Besides, there is no real reason why sharp edges should exist in the majority of cases, as properly rounded edges look quite as well and cost no more to produce in the moulding shop. There are, necessarily, cases where castings have to be got out with sharp, square edges, but these are not amongst the general run of machinery castings.

With flanged pipes which have to stand pressure, the question of granular arrangement of the metal is of particular importance, a pipe cast, as shown in Fig. 5, being very likely to fracture at the points shown by the dotted lines, while one cast with a heavy fillet, as shown in Fig. 6, is not liable to break, even if the fillet is turned off after the casting is made. The strongest arrangement for flanged pipes, however, is that shown in Fig. 7, as in this the grain of the metal is continuous, and although fractures are not entirely preventible in any form, there is less chance of breakage occurring with this form.

In making malleable castings, unless all parts are curved or filletted where they join others at right angles, there is always a very serious chance of having either holes or segregation spots, either of which tends to weaken the article when finished. Generally this fault occurs as shown in Fig. 8, and owing to the hardness of the iron used there appears to be little chance of preventing it unless the more costly brands of iron are used. So far as can be managed, sharp angles should be avoided in this class of work, the design of malleable castings being carefully considered to this end.

The use of cast iron in places where no special strength is needed does not, of course, call for such serious consideration as where strength is an important feature, but still the question of the avoidance of sharp cast edges should be considered, the mere chamfering of the edge to show a quarter-inch flat on the chamfer greatly improving the security of the part against chipping and damage. Indeed, with some forethought in the drawing office cast work can often be improved in durability without loss of smartness of design, and if through all stages the work of preparing castings is carried out systematically much improved work can be produced.

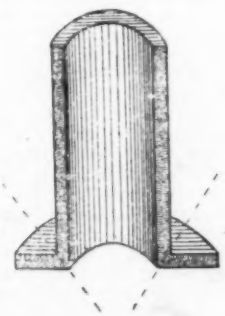


FIG. 5.

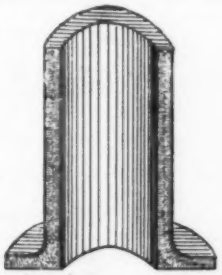


FIG. 6.

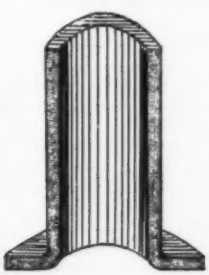


FIG. 7.

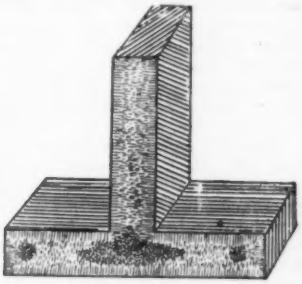


FIG. 8.

Case-Hardening.

By Henry A. Vanvught.*

It is now twenty years since I last wrote on the subject of case-hardening.* During these two decades the process of case-hardening, or carburising, has become of increasing importance, and, therefore, in view of the ever growing utility of the process I think it may be of some benefit to the readers of this journal to give a few particulars based upon my own practical experience on the subject, extending over a period of more than forty years.

The process of case-hardening consists of adding such a percentage of carbon to the outer surface of iron or mild steels as will produce a hardened casing, whilst the interior structure of the metal still retains its original tenacity. Case-hardening is conducted in nearly every engineering establishment, but my own observation tends to show that in many cases practical knowledge on the subject is not altogether evident, and that even in the present age of progress and keen competition rule-of-thumb methods prevail in some establishments, where thousands of pounds have been expended in up-to-date scientific appliances in every department except in the all-important one of case-hardening. As the result of this "laisser-faire," or to put it in plain English, "happy-go-lucky" state of things, many valuable parts of machinery are daily spoilt and thrown on the scrap heap, thus incurring a much greater loss than the initial expenditure for the proper case-hardening appliances and material would involve.

FIG. 1.—3-IN. MILD STEEL BAR, CASE-HARDENED.

This apathy is by no means confined to this country. A tour throughout Europe and America which I made some time ago has convinced me that case-hardening plant in almost every country is considerably in arrear of modern progress. The acquisition of efficacious case-hardening material is of the foremost importance to most branches of engineering, more particularly locomotive builders, motor and cycle manufacturers, who require very hard yet tenacious material so as to obtain satisfactory results.

Case-hardening is often put in the same category as cementation, but this is a mistake; in the process of cementation the carbonising is carried entirely through the metal, whereas in case-hardening the penetration is interrupted so as to form a dead-hard case of carburised metal. The Harveyising and Krupp processes are plainly a more advanced form of case-hardening. Nitrogen and free carbon mixed with certain chemicals invariably form the substance of a really good case-hardening compound. During my forty years' technical career I have introduced in almost every industrial centre of the world a series of case-hardening processes amounting to 253 distinct formulas. In selecting a case-hardening compound it is of vital importance to obtain a guarantee as to the non-injurious nature of the ingredients of which the material is composed. Too much nitrogen will mean crystallisation, whereas compounds of the element sodium, will involve scaling or sweating. The use of the old-fashioned bone and leather processes without the addition of the free carbon and certain chemicals will make the work too brittle; therefore the users of case-hardening compounds should really insist on a guarantee as to the right percentage and proper quality of the ingredients forming the composition of their case-hardening material. Scores of people now-a-days introduce mixtures for case-hardening. These mixtures are sold under many fancy names, and in most cases at fancy prices, and contain nitrogen and even common salt. On proper analysis, however, we find that in most cases the percentage of nitrogen is either too low or too high; the latter is even more injurious to the metal than the former. As already stated, nitrogen alone is very risky to the metal and unreliable, while the use of free carbon alone is a very tedious process; therefore, what is needed to obtain proper results is a judicious combination of nitrogen and free carbon. Of course, the mild steel manufactured by one firm is not always of the same class as that of another. Steel of the following analysis is generally accepted to be the most suitable for case-hardening:—Silicon, 0.14 per cent.; sulphur, 0.01 per cent.; phosphorus, 0.08 per cent.; manganese, 0.58 per cent.; iron (by difference), 99.19 per cent. A mixture of 60 per cent. nitrogen and 40 per cent. free carbon in some form or other will be found most efficacious for case-hardening of the above-mentioned steel.

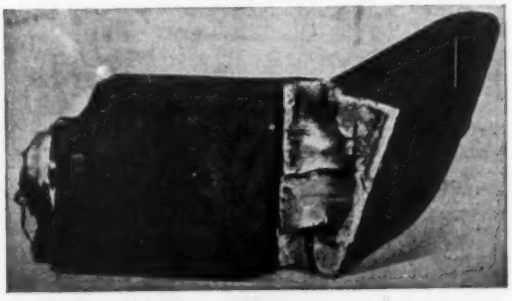


FIG. 2.—PART OF LOWMOOR-IRON BEATER, CASE-HARDENED.

Many well-known authorities at home and abroad advocate the use of 60 per cent. vegetable charcoal and 40 per cent. of carbonaceous chemicals, but my experience and constant observation have proved that we cannot lay down any hard-and-fast rules on the subject. It has also been my experience that, whereas we obtained a most excellent result of the case-hardening mixture with one class of steel, the same mixture proved an utter failure when applied to a different make; it is therefore sufficiently clear that in order to do case-hardening thoroughly

* "Railway Supply Journal," September, 1890.

we have to study the suitability of case-hardening mixture for the particular class of steel employed.

How to Case-Harden.

Owing to the introduction of various classes of mild steel, it has been necessary from time to time to introduce a great variety of case-hardening compounds. The real method of case-hardening does not fundamentally differ in any way from that practised by our great-grandfathers. The furnace or muffle should be of a natural down-draft construction, built in such a manner as to allow the heat to be evenly distributed around the case-hardening chamber. The furnace should be built in a place where not too much daylight penetrates, so as to better ascertain the right heat of the metal; the door of the case-hardening chamber should be fitted with an 1½-in. peep-hole, but the door itself should never be opened during the time the work is in the furnace. The utmost care should be taken that no oxygen comes in contact with the work whilst the process of case-hardening is going on. A temperature of 900 degrees C. is considered most suitable for case-hardening, and this temperature should be maintained throughout the process. To ascertain the right temperature the use of a Baird & Tatlock thermocouple pyrometer may be recommended. In places where gas can be obtained in an economical way a gas furnace may be used. There are several of these on the market and they are practically all constructed on the same system. When possible, the hardening cases should be made of wrought iron, ½ in. in thickness. The size of the boxes, of course, depends upon the quantity and dimensions of articles which are to be hardened at a time. The boxes should be packed as follows:—Cover the bottom with the case-hardening material at least 1 in. in thickness; place thereon the article or articles to be hardened and pack with case-hardening material in such a manner that they are separated from one another by at least half an inch. Any number of articles of different sizes and dimensions may, if necessary, be hardened in one operation, but it is not advisable to put different classes of metal, such as mild steel and wrought iron, into the same hardening box, as the former requires twenty-five per cent. longer time for heating than the latter, to obtain the same penetration. The box should be closed, almost but not entirely air tight, as hermetically closing the box may in some cases cause explosion by evaporation of the moisture which, however small in quantity, is always present in the hardening compound. Four hours' heating at 900 degrees C. will generally be found adequate to obtain $\frac{1}{16}$ in. penetration in the case of wrought iron, whilst for mild steel five hours' heating should be given. In the event of a deeper penetration being required, an increase of the above times by 50 per cent. will generally produce a further $\frac{1}{16}$ in. thickness of case. At the expiration of the required time of heating the box should be withdrawn from the furnace, and the article immediately extracted and plunged into cold water, but bars, spindles, etc., above six inches in length should be cooled perpendicularly, and lowered slowly into the water to prevent bending or buckling them.

It often happens that the coverplate sinks owing to the shrinkage of the bulk inside the hardening box, and thus the gases essential for the hardening escape. It is therefore of the utmost importance that the cover plate be kept in its position, and this can best be done by putting four uprights inside the box, one in each corner, on which the cover plate will rest. This will make it impossible for it to get out of its position.

For ascertaining the penetration of the case-hardening it is advisable to put into the same box a few test pieces which, after hardening, may be broken, and the test pieces should be of the same steel, or iron, as the case-hardened articles.

In the case of mild steel, it is often necessary to reheat the articles; in that event they should be naturally cooled down, then replaced in the furnace and reheated to about 650 degrees C., whereupon the article should be plunged into water in the usual way. It is also of importance to have always fresh, if possible running, water; this part of the process is often very much neglected.

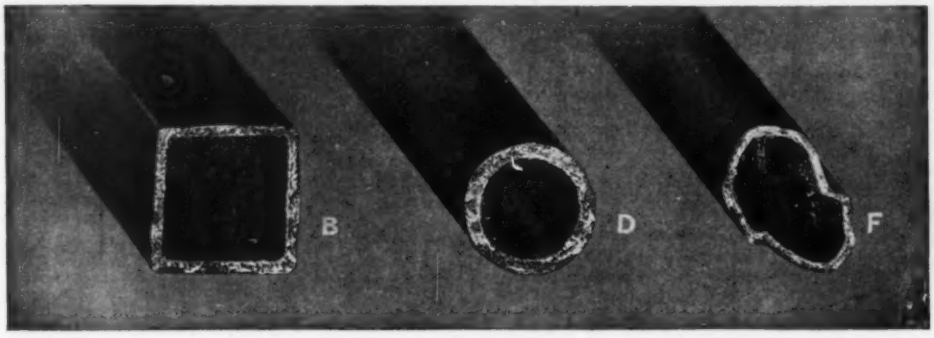


FIG. 3.—FRACTURES OF SWEDISH IRON, CASE-HARDENED.

A few reproductions of specimens of hardened test pieces are given herewith. Fig. 1 shows a 3-in. mild steel bar case-hardened to a full ⅛ in. The interior structure has been almost strictly retained; as will be seen, the bar is bent to a most remarkable degree. Fig. 2 is part of a Lowmoor-iron beater, hardened at a temperature of 900 degrees C. during 2 hours, penetrating $\frac{1}{16}$ in. without reheating. Fig. 3 shows a few fractures of Swedish iron reproduced in their natural size. This iron was hardened during 5½ hours in a muffle as described above, and the square specimen B was broken after being submitted to the Brinell test under the supervision of Mr. R. H. Harry Stranger, of the Broadway Testing Works, Westminster.

All the above specimens have been hardened by "Durvite," which, in contrast with most other compounds, is an all-British product.* To procure a reliable case-hardening compound does not always mean the payment of fancy prices.

* Durvite (1909) Ltd., 112a, Queen Victoria Street, E.C.

The Effect of a Sinking Head on Large Castings.*

By Thomas Kennedy.

Large pipes are, as a rule, specified to be cast on end, with the upper end prolonged to form a sinking head, which is afterwards cut off. The object of this Paper is to show the advantages and desirability of this in nearly all large castings—taking, as illustration, the results obtained in casting some large columns about 32 ft. long, weighing about 12 tons, where a sinking head 2 ft. 10½ in. long, and weighing about 2 tons, was added. When this head was cut off, and broken under the ball, the fracture was very interesting. It showed that the head, which was much larger in area than the column proper, had been most efficiently feeding the column, while the molten metal in it was contracting during setting. It showed a good deal more than that. In the large pockets left by the receding cooling metal, there were groups of crystals of pure iron. The crystals group together so that they all interlace one with another, the other ingredients combining with some of the iron, and forming a matrix which fills the interstices. The real strength of the casting is in these interlaced groups of crystals. In the body of such a casting, the crystals exist in identically the same form though much smaller, due to the quicker cooling, perfectly interlaced and homogeneous, owing to the great pressure above them of the slower-cooling sinking head.

The most deleterious impurities contained in cast iron, as it leaves the cupola, are slag globules, gases mechanically contained in the metal, and gases technically called "occluded" or absorbed physically in the metal, all or most of which will separate out as the metal passes from the liquid to the solid state. The excess of carbon in the metal separates into little plates of graphite as the metal solidifies; and there are also crystals of a very brittle substance known as phosphide of iron, and little areas of sulphide of manganese. All these substances are potentially in the metal as it leaves the cupola and goes into the ladle. As the metal is being poured into the mould, still more gases are formed by the action of the hot metal on the sand of the mould. The bulk of these escape through the cores and joints of the boxes in which the mould is formed, and when ignited burn with a non-luminous flame. The remainder of all the impurities mentioned—slag, gases, excessive graphite, etc.—are of a much less gravity than the proper metal; and if they have a free passage in the mould, they escape upwards to the top, but if not, they remain, and the result is a porous, weak casting.

When a long column, such as has been described, is cast on a sloping bank instead of vertically, crystals always begin forming at right angles to the cooling surface, with the result that millions of crystals form round the mould, and the passage of impurities is seriously impeded. If the column is cast horizontally, their escape is rendered impossible, and they remain in the top side of the casting.

In small, thin castings, the cooling is so rapid, and the gate is so near the body of the casting, that sinking heads are not necessary, as the air and gases escape readily, and the impurities have no time to segregate; but being spread more or less uniformly over the whole casting, their effect is so diminished as to be practically negligible.

* Abstract of a Paper read before the Association of Water Engineers.

Discussion.

Mr. Alfred Towler remarked that the author did not mention one of the practical reasons why pipes and columns of considerable length were cast vertically in preference to being cast at an angle or horizontally. If cast at an angle or horizontally, there was some difficulty in preventing the core getting out of the straight line. It bent with the heat; and there was the tendency of the metal to lift it. Such things as water-pipes with spigot and socket joints that did not require machining, could be dealt with in the ordinary way; but when they were dealing with columns, such as rams, and so forth, which required machining, it was quite another problem. The author had not dealt much with mixtures, and probably for a very good reason. People who got out specifications for pumping machinery sometimes told the makers what mixtures to employ; and at times this made matters exceedingly difficult for the manufacturers. Different sorts of castings wanted to be treated differently with regard to the mixtures. The Germans had recently brought out means for compressing iron borings and turnings and making them into briquettes, so using up waste products. These borings and turnings did not realise anything like their real value, because it had been found very difficult indeed to melt them up again in the loose state, seeing that a good deal of it was oxidised, and thrown away by the blast.

Mr. R. A. Blakeborough said he should like to know the shape from top to bottom of the pillars mentioned by the author. Sometimes where there was a large flange on the outside of a column, or the casting was of an irregular shape, it was advisable to have more than one header to take away the impurities.

Mr. H. Preston said the author had referred to the decomposition of iron owing to electrolytic action between the iron and the graphite. They had at times mains which seemed to decompose when placed in the ground. When in clay all the nature of the iron would go out of it. A pick striking it would go straight through without cracking it; and such pipes could be cut with a knife. If the pipes were laid where there was furnace slag, the same action would come about. Was that the action to which Mr. Kennedy had referred? And what was really the chemical action that took place under these two conditions—in clay and in furnace slag?

Mr. Kennedy, in reply, remarked regarding the question as to briquettes, that his firm had never used them. Steel briquettes were sometimes used, but he did not think it was a very desirable thing to do, because the steel was apt to segregate and get into different parts of the metal, making it irregular. It was, however, quite a common thing to use the steels from rolling hot plates. This was not so dangerous as putting in lumps of steel. Briquettes were not greatly known to metal users in this country. In reference to the large columns, there were flanges at both ends; but there was nothing in the centre, except a piece put in for a test bar. As to electrolytic action, where there was graphite in large patches in close contact with large masses of iron, and there was acid in the ground or water, galvanic action was set up which carried off the iron, either as ferro-carbonate or some other oxide of iron. The effect was the same whether from inside or outside.

Chemical Standards for Iron Castings.

(*Continued from page* 372.)

In our last issue we published part of this extract from the report of the Committee of the American Foundrymen's Association on Standards for Iron Castings, by Dr. John Jermain Porter (University of Cincinnati). The concluding section of the analyses and suggested specifications are given herewith:—

Ref.	Silicon Per cent.	Sulphur Per cent.	Phos. Per cent.	Mang. Per cent.	Comb. Carb. Per cent.	Total Carb. Per cent.
Car Wheels, Chilled.						
51	.50-.70	.05-.07	.35-.45	.30-.50	.50-.75	3.50
171	.58-.68	.05-.08	.25-.45	.15-.27	.63-1.0	—
171	.73	.080	.43	.44	1.25	4.31
171	.86	.127	.35	.49	.92	3.47
126	.70	.080	.50	.40	.60	3.50
—	.58	.141	.38	.48	.90	3.63
—	.57	.101	.41	.42	—	—
—	.68	.188	.36	.53	—	—
—	.67	.170	.38	.81	.74	3.66
—	.50-.60	.08-.10	.30-.40	.45-.55	.70-.80	3.50
Sug.	.60-.70	.08-.10	.30-.40	.50-.60	.60-.80	3.50-3.70
Car Wheels, Unchilled. See Wheels						
Chemical Castings. See Acid Resisting Castings						
Chilled Castings						
135	.80-1.00	.09-.11	.50	.50	—	—
197	1.20-1.40	—	low	—	—	low
69	1.00	.08	.40	.75	—	3.25
65	1.35	.117	.09	.54	.65	3.00
—	.50	.200	.45	1.50	3.00	3.00
—	1.20	.090	.30	.50	1.20	3.20
—	1.20	.080	.30	1.25	—	3.50
—	.75	.090	.30	.30	3.00	3.20
Sug.	.75-1.25	.08-1.0	.20-.40	.80-1.2	—	—
Chills						
105	2.07	.073	.31	.48	.23	2.64
Sug.	1.75-2.25	und. .07	.20-.40	.60-1.0	—	—
Collars and Couplings for Shafting						
—	1.60	.040	.55	.55	.30	3.57
Sug.	1.75-2.00	und. .08	.40-.50	.60-.80	—	—
Cotton Machinery. See also Machinery Castings						
—	2.20-2.30	und. .09	.70	.60	.45	3.45
Sug.	2.00-2.25	und. .08	.60-.80	.60-.80	—	—
Crusher Jaws						
135	.80-1.00	.09-.11	.50	.50	—	—
69	1.00	.080	.40	.75	—	3.25
—	.50	.20	.45	1.50	3.00	3.00
Sug.	.80-1.00	.08-.10	.20-.40	.80-1.2	—	—
Cutting Tools, Chilled Cast Iron						
65	1.35	.117	.60	.54	.65	3.00
Sug.	1.00-1.25	und. .08	.20-.40	.60-.80	—	—
Cylinders. See Air Cylinders, Ammonia Cylinders, Automobile Cylinders, Gas Engine Cylinders, Hydraulic Cylinders, Locomotive Cylinders, Steam Cylinders						
Cylinder Bushings, Locomotive. See Locomotive Castings, Heavy						
Dies for Drop Hammers						
171	1.40	.060	.10	.40	—	—
—	1.40	.090	.40	.70	1.00	3.20
Sug.	1.25-1.50	und. .07	und. .20	.60-.80	—	low.
Diamond Polishing Wheels						
105	2.70	.063	.30	.44	1.60	2.97
Dynamo and Motor Frames, Bases and Spiders, Large						
171	1.95	.042	.40	.39	.59	3.82
—	1.90	.080	.47	.60	.64	3.79
—	2.15	.070	.75	.60	.55	3.80
—	2.10	.070	.55	.40	—	3.50
Sug.	2.00-2.50	und. .08	.50-.80	.30-.40	.20-.30	low
Dynamo and Motor Frames, Bases and Spiders, Small						
171	3.19	.075	.89	.35	.06	2.95
—	2.30	.070	.55	.40	—	3.50
—	2.50	.070	.75	.60	.55	3.95
Sug.	2.50-3.00	und. .08	.50-.80	.30-.40	.20-.30	low
Electrical Castings						
171	3.19	.075	.89	.35	.06	2.95
171	1.95	.042	.40	.39	.59	3.82
—	1.90	.080	.47	.60	.64	3.79
—	2.15	.070	.75	.60	.55	3.80
—	2.50	.070	.75	.60	.55	3.95
—	2.10	.070	.55	.40	—	3.50
—	2.30	.070	.55	.40	—	3.50
Sug.	2.00-3.00	und. .08	.50-.80	.30-.40	.20-.30	low
Eccentric Straps. See Locomotive Castings and Machinery Castings						
Engine Castings. See Bed Plates, Engine Frames, Fly Wheels, Locomotive Castings, Machinery Castings, Steam Cylinders						
Engine Frames. See also Machinery Castings						
—	2.25	.080	.55	.60	—	—
—	1.60	.090	.50	.60	—	—
—	1.32	.100	.40	.60	—	—
Sug.	1.25-2.00	und. .09	.30-.50	.60-1.0	—	—
Fans and Blowers. See Machinery Castings						
Farm Implements						
—	2.00	.089	.89	.46	.50	3.39
—	2.10	.068	.68	.45	.47	3.32
Sug.	2.00-2.50	.06-.08	.50-.80	.60-.80	—	—
Fire Pots						
194	2.50	und. .07	und. .20	.80-1.0	—	—
Sug.	2.00-2.50	und. .06	und. .20	.60-1.0	—	low
Fly Wheels. See also Automobile Fly Wheels and Machinery Castings						
—	2.20	.060	.55	.50	—	—
—	1.50	.090	.50	.60	—	—
Sug.	1.50-2.25	und. .08	.40-.60	.50-.70	—	—
Friction Clutches						
64	2.00-2.50	und. .15	und. .70	und. .70	—	—
Sug.	1.75-2.00	.08-.10	und. .30	.50-.70	—	low
Furnace Castings						
94	2.50	und. .07	und. .20	.80-1.0	—	—
—	2.00	.085	.35	.53	—	—
—	1.85	.090	.70	.60	—	—
Sug.	2.00-2.50	und. .06	und. .20	.60-1.00	—	low
Gas Engine Cylinders						
137	1.45	—	—	.65	—	—
—	1.98	.090	.84	.63	—	—
—	1.21	.117	.40	.35	1.40	3.74
—	1.00-1.25	.04-.08	.20-.40	.70-.80	.60-.80	3.00-3.10
Sug.	1.00-1.75	und. .08	.20-.40	.70-.90	—	3.00-3.50
Gears, Heavy						
171	1.40	.060	.10	.40	—	—
—	.94	.150	.43	.31	1.47	—
—	1.60	.080	.40	.60	—	3.50
—	1.50-1.75	.080	.40-.60	.50-.70	—	—
—	1.00-1.25	.075	.40	.80-1.0	—	very low
—	1.40-1.60	.04-.08	.30-.50	.40-.60	.50-.80	3.20-3.40
Sug.	1.00-1.50	.08-.10	.30-.50	.80-1.0	—	low
Gears, Medium						
64	1.50-2.00	und. .08	.35-.60	.50-.80	—	—
171	1.90	.060	.10	.40	—	—
—	2.30	.060	.60	.60	—	3.75
—	1.90	.100	.69	.58	.55	3.83
Sug.	1.50-2.00	und. .09	.40-.65	.70-.90	—	—
Gears, Small						
198	3.43	—	1.42	.90	—	—
—	2.00	.100	.50	.70	—	3.50
Sug.	2.00-2.50	und. .08	.50-.70	.60-.80	—	—
Grate Bars						
195	2.75	low	low	—	—	—
—	2.00	.085	.35	.53	—	—
Sug.	2.00-2.50	und. .06	und. .20	.60-1.0	und. .30	low
Grinding Machinery, Chilled Castings for						
—	.50	.200	.45	1.50	3.00	3.00
Sug.	.50-.75	.15-.20	.20-.40	1.5-2.0	—	—
Gun Carriages						
171	.94	.050	.44	.31	.63	3.03
171	1.00	.050	.30	.60	1.10	2.50
Sug.	1.00-1.25	und. .06	.20-.30	.80-1.0	—	low
Gun Iron						
171	1.34	.003	.08	1.00	.93	3.12
171	1.19	.055	.41	.42	1.13	3.18
171	1.53	.050	.29	.45	.42	3.43
171	.98	.060	.43	.43	.75	1.74
198	.30	—	.44	3.55	1.70	3.90
—	1.20	.100	.30	.80	1.00	3.00
Sug.	1.00-1.25	und. .06	.20-.30	—	.80-1.0	low
Hangers for Shafting						
—	1.60	.040	.55	.55	.30	3.57
Sug.	1.50-2.00	und. .08	.40-.50	.60-.80	—	—

Ref.	Silicon Per cent.	Sulphur Per cent.	Phos. Per cent.	Mang. Per cent.	Comb. Carb. Per cent.	Total Carb. Per cent.
Hardware, Light						
193	1.84	—	.58	1.04	—	—
198	2.50	—	.74	1.10	—	—
193	2.50	—	1.21	1.16	—	—
—	2.51	.110	.62	.41	.24	3.18
—	2.70	.030	.60	.56	.40	3.60
—	2.50	und. .030	.60	.70	—	—
—	2.00-2.25	.050	.85	.40	—	3.85-4.00
Sug.	2.25-2.75	und. .08	.50-.80	.50-.70	—	—
Heat Resistant Iron						
171	1.20	.060	.10	.40	—	—
171	1.67	.032	.09	.29	.13	3.87
134	2.15	.086	1.26	.41	.13	3.39
134	2.02	.070	.89	.29	.84	3.60
198	1.53	.040	.33	1.08	.53	3.61
105	2.07	.073	.31	.48	.23	2.64
81	1.80	.030	.70	.65	—	—
195	2.75	low	low	—	—	—
194	2.50	und. .07	und. .20	.80-1.0	—	—
—	1.76	.075	.61	.79	.56	3.63
—	2.01	.030	.70	—	—	—
Sug.	1.25-2.50	und. .06	und. .30	.60-1.00	und. .30	low
Hollow Ware						
—	2.51	.110	.62	.41	.24	3.18
Sug.	2.25-2.75	und. .08	.50-.70	.50-.70	—	—
Housings for Rolling Mills						
—	1.00-1.25	.085	.65	.75	—	low
Sug.	1.00-1.25	und. .08	.20-.30	.80-1.0	—	low
Hydraulic Cylinders, Heavy						
171	1.00	.050	.30	.60	1.10	2.50
22	.90	.136	.39	.25	1.44	3.34
63	.80-1.50	.07-.11	.35-.50	—	—	—
—	1.12	.085	.40	.70	.70	3.50
—	.95	.100	.30	.90	.80	3.40
—	1.15	und. .08	.50	.60	1.15	—
—	.90-1.20	.06-.08	.30-.50	.80-1.0	.80-1.0	2.90-3.10
Sug.	.80-1.20	und. .10	.20-.40	.80-1.0	—	low
Hydraulic Cylinders, Medium						
171	1.40	.060	.10	.40	—	—
—	1.90	.074	.50	.65	—	—
—	1.62	.08	.50	.60	—	—
—	1.75	.070	.40	.55	.50	—
Sug.	1.20-1.60	und. .09	.30-.50	.70-.90	—	low
Ingot Moulds and Stools						
171	1.20	.060	.10	.40	—	—
171	1.67	.032	.09	.29	.43	3.87
Sug.	1.25-1.50	und. .06	und. .20	.60-1.0	—	—
Locomotive Castings, Heavy						
57	1.40-2.00	und. .085	und. .60	und. .70	—	—
—	1.25-1.50	.06-.08	.40-.60	.45-.60	.50-.70	3.50
—	1.62	.098	.40	.49	—	—
Sug.	1.25-1.50	und. .08	.30-.50	.70-.90	—	—
Locomotive Castings, Light						
57	1.40-2.00	und. .085	und. .60	und. .70	—	—
—	1.50-2.00	.06-.08	.40-.60	.45-.60	.45-.55	3.50
Sug.	1.50-2.00	und. .08	.40-.60	.60-.80	—	—
Locomotive Cylinders						
126	1.25-1.75	und. .10	und. .90	—	—	—
57	1.40-2.00	und. .085	und. .60	und. .70	—	—
—	1.25-1.50	.06-.08	.40-.60	.45-.60	.50-.70	3.50
—	1.00-1.40	und. .11	.40-.90	.40-.90	—	—
—	1.41	.092	.38	.36	—	—
—	1.56	.061	.45	.78	—	—
Sug.	1.00-1.50	.08-.10	.30-.50	.80-1.0	—	—
Locks and Hinges. See Hardware, Light						
Machinery Castings, Heavy						
171	1.05	.110	.54	.35	.33	2.98
178	.85	.030	.37	.92	—	—
63	.80-1.50	.030-.050	.35-.50	—	—	—
—	.90-1.50	.09-1.2	.15-.40	.20-.80	.10-.30	2.50-2.90
—	1.85	.100	.50	.60	—	3.50
—	1.30	.080	.40	.60	—	—
—	1.85	.120	.60	.45	—	3.40-3.55
—	1.75	.100	.50	.70	.80	3.65
Sug.	1.00-1.50	und. .10	.30-.50	.80-1.0	—	low
Machinery Castings, Medium						
171	1.83	.078	.50	.31	.43	2.93
—	2.25	.080	.55	.60	—	—
—	1.60	.060	.66	—	—	—
—	2.29	.071	.66	.49	—	—
—	1.60	.090	.50	.60	—	—
—	2.10	.110	.67	.50	—	3.40-3.55
—	2.25	.080	.75	.55	—	—
—	2.00	.100	.75	.50	.75	3.50
—	1.76	.075	.63	.79	.56	3.68
—	2.00	.100	.50	.50	.50	3.60
—	2.35	.075	.45	.65	.30	—
—	1.80	.060	.80	.50	.70	—
—	2.06	.075	.78	.47	—	3.45
—	1.40	low	.20	.40	—	—
—	2.00	.030	.70	—	—	—
—	1.85	.080	.60	.50-.60	.50	3.25-3.50
—	1.50-2.10	.04-.09	.40-.80	.20-.60	.10-.40	2.60-3.20
—	1.80-2.10	und. .09	.40-.90	.40-.90	—	—
Sug.	1.50-2.00	und. .09	.40-.60	.60-.80	—	—

Ref.	Silicon Per cent.	Sulphur Per cent.	Phos. Per cent.	Mang. Per cent.	Comb. Carb. Per cent.	Total Carb. Per cent.
Machinery Castings, Light						
171	2.04	.044	.58	.39	.32	3.84
—	2.25	.080	.70	.50	.20	3.55
—	2.76	.037	1.19	—	.13	3.66
—	2.49	.097	.90	.42	—	3.40
—	2.51	.081	.62	.61	—	3.46
—	2.50	.100	.60	.70	—	3.50
—	3.00	.060	.65	.50	—	3.53
—	2.40	.050	.47	.59	—	—
—	2.85	.064	.67	.65	—	—
—	2.52	.052	.66	.68	—	—
—	3.15	.050	—	—	—	—
—	2.50	.100	.70	.60	—	3.40-3.55
—	2.20-2.80	.06-.08	.60-1.3	.20-.40	.10-.60	3.00-3.60
Sug.	2.00-2.50	und. .08	.50-.70	.50-.70	—	—
Machine Tool Castings. See Machinery Castings						
Motor Frames, Bases and Spiders. See Dynamo						
Moulding Machines. See Machinery Castings						
Mowers. See Agricultural Machinery						
Nitre Pots. See Acid Resisting Castings and Heat Resisting Castings						
Ornamental Work						
171	4.19	.080	1.24	.67	.03	2.88
—	2.51	.110	.62	.41	.24	3.18
—	2.25	—	.60-.90	—	—	—
Sug.	2.25-2.75	und. .08	.60-1.0	.50-.70	—	—
Permanent Moulds						
134	2.15	.086	1.26	.41	.13	3.30
134	2.02	.070	.89	.29	.84	3.60
Sug.	2.00-2.25	und. .07	.20-.40	.60-1.0	—	—
Permanent Mould Castings						
93	2.00-3.00	—	—	—	—	3.00-4.00
—	1.50-3.00	und. .06	—	und. .40	—	—
Piano Plates						
197	2.00	low	.40	.60	—	—
Sug.	2.00-2.25	und. .07	.40-.60	.60-.80	—	—
Pillow Blocks						
—	1.60	.040	.55	.55	.30	3.50
Sug.	1.50-1.75	und. .08	.40-.50	.60-.80	—	—
Pipe						
—	2.00	.060	.60	.60	—	—
—	2.00	.060	1.00	.60	—	—
Sug.	1.50-2.00	und. .10	.50-.80	.60-.80	—	—
Pipe Fittings						
198	2.88	—	.41	1.10	—	—
—	1.70	.058	.50	.73	1.16	4.18
—	2.51	.110	.62	.41	.24	3.18
Sug.	1.75-2.50	und. .08	.50-.80	.60-.80	—	—
Pipe Fittings for Superheated Steam Lines						
75	1.72	.085	.89	.48	.17	2.45
75	1.40-1.60	.06-.09	.20-.40	.45-.75	—	3.00-3.25
Sug.	1.50-1.75	und. .08	.20-.40	.70-.90	—	low
Piston Rings						
137	1.35	—	—	.40	—	—
—	1.60	.08	1.15	.35	.60	—
—	1.50-2.00	.06-.08	.40-.60	.45-.60	.45-.55	3.50
Sug.	1.50-2.00	und. .08	.30-.50	.40-.60	—	low
Plough Points, Chilled						
197	1.20-1.40	—	low	—	—	low
—	1.20	.090	.30	.50	1.20	3.20
—	.75	.090	.30	.30	3.00	3.20
—	1.20	.080	.30	1.25	—	3.50
Sug.	.75-1.25	und. .08	.20-.30	.80-1.0	—	—
Printing Presses. See Machinery Castings						
Propeller Wheels						
—	1.15	—	.32	.51	.60	—
—	1.40	low	.20	.40	—	—
Sug.	1.00-1.75	und. .10	.20-.40	.60-1.0	—	low
Pulleys, Heavy						
—	1.75	.040	.55	.55	.30	3.57
—	2.40	.060	.60	.60	—	3.75
Sug.	1.75-2.25	und. .09	.50-.70	.60-.80	—	—
Pulleys, Light						
64	2.20-2.80	und. .08	und. .70	und. .70	—	—
14	2.40	und. .08	.95	.70	—	—
—	2.74	.040	.50	.66	—	—
—	2.52	.075	.77	.63	—	3.37
—	3.35	.089	.70	.47	—	3.42
—	2.25	.040	.55	.55	.30	3.57
—	2.15	.080	.70	.60	.40	3.55
Sug.	2.25-2.75	und. .08	.60-.80	.50-.70	—	—
Pumps, Hand						
—	2.30-2.75	und. .08	.60-1.0	.30-.50	—	—
Sug.	2.00-2.25	und. .08	.60-.80	.50-.70	—	—
Radiators						
—	2.15	low	.80	.45	.50	3.50
—	2.45	.104	.44	.40	.35	3.40
Sug.	2.00-2.25	und. .08	.60-.80	.50-.70	.50-.60	—

Ref.	Silicon Per cent.	Sulphur Per cent.	Phos. Per cent.	Mang. Per cent.	Comb. Carb. Per cent.	Total Carb. Per cent.
Railroad Castings						
61	2.20-2.80	und. .08	und. .70	und. .70	—	—
—	1.40-1.80	.05-.08	.50-.80	.45-.60	.40-.65	3.50
—	2.25	.050	.60	.75	—	—
—	1.75	.070	.85	.60	—	—
Sug.	1.50 2.25	und. .08	.40-.60	.60-.80	—	—
Retorts. See Heat Resistant Castings.						
Rolls, Chilled						
171	.50-1.00	.01-.06	.20-.80	.15-1.5	2.60-3.25	—
171	.80	.100	.88	.16	.91	2.84
171	.71	.058	.54	.39	1.38	3.03
173	.65	.050	.25	1.53	.63	3.50
Sug.	.60-.80	.06-.03	.20-.40	1.0-1.2	—	3.00-3.25
Rolls, Unchilled (Sand Cast)						
171	.75	.030	.25	.06	1.20	4.10
Scales						
198	1.67	—	1.92	1.90	—	—
198	2.12	—	.61	.80	—	—
198	1.70	—	.63	1.60	—	—
Sug.	2.00-2.30	und. .08	.60-1.0	.50-.70	—	—
Slag Car Castings						
—	1.76	.075	.63	.79	.56	3.68
—	2.00	.030	.70	—	—	—
Sug.	1.75-2.00	und. .07	und. .30	.70-.90	—	—
Smoke Stacks, Locomotive. See Locomotive Castings						
Soil Pipe and Fittings						
—	2.00	.060	1.00	.60	—	—
Sug.	1.75-2.25	und. .09	.50-.80	.60-.80	—	—
Steam Cylinders, Heavy						
—	1.41	.092	.38	.39	—	—
—	.95	.160	.30	.90	.80	3.40
—	1.10	.136	.43	.33	.99	3.30
—	1.00	.080	.20-.30	1.00	.75	3.00
—	1.35-1.50	.080	.50	.75	—	3.65
—	1.20 1.40	.04-.08	.40-.50	.70-.80	.70 .80	3.00-3.20
111	.90-1.20	.09-.12	.20-.40	.70 .90	—	und. 3.50
Sug.	1.00-1.25	und. .10	.20-.40	.80-1.0	—	low
Steam Cylinders, Medium						
70	1.66	.055	.70	.80	—	—
70	1.60	.063	.72	.85	—	—
70	1.70	.070	.70	.75	—	—
70	1.70	.075	.60	.92	—	3.50
14	1.40-2.00	.085	.70	.30-.70	—	—
61	1.50-2.00	und. .08	.25.60	.50 .80	—	—
—	1.40-1.60	und. .09	.40 90	.40-.90	—	—
—	1.50-1.65	.080	.60	.60-.70	—	—
—	1.50-1.80	.070	.43	.76	—	—
—	1.85	.080	.60	.50-.60	.50	3.25-3.50
—	1.75	.100	.65	.55	—	3.40-3.55
—	1.32	.136	.43	.33	.99	3.30
—	1.12	.085	.40	.70	.70	3.50
—	2.00	.100	.50	.70	.40	3.50
—	2.00	.070	.30	.60	—	—
—	1.50	.070	.75	.70	—	3.50
—	1.59	.100	.60	.38	—	3.34
—	1.86	—	.20	.55	.52	—
—	1.90	.074	.50	.65	—	—
—	1.56	.061	.45	.78	—	—
Sug.	1.25-175	und. .09	.30-.50	.70-.90	—	—
Steam Chests. See Locomotive Castings and Machinery Castings						
Stove Plate						
198	2.90	—	.73	1.40	—	—
171	2.59	.072	.62	.37	.35	3.30
171	3.19	.084	1.16	.38	.33	3.41
—	2.75	.050	1.00	.80	.18	3.38
—	2.79	.077	1.40	.32	.20	3.22
—	2.51	.110	.62	.41	.24	3.18
—	2.76	.071	.63	.63	.37	3.50
—	2.76	.084	.65	.54	—	—
—	2.50	.060	1.00	.60	—	—
—	2.60	.050	.60	.60	—	—
—	2.50-3.00	und. .10	.60-.80	.40-.60	—	3.00-4.00
Sug.	2.25-2.75	und. .08	.60-.90	.60-.80	—	—
Valves, Large						
64	1.20-1.50	und. .09	.35-.60	.50 .80	—	—
136	1.70	.160	.50	.90	—	—
—	1.67	—	.25	.45	.49	—
Sug.	1.25-1.75	und. .03	.20 .40	.80-1.0	—	—
Valves, Small						
—	1.70	.058	.50	.74	1.16	4.18
—	2.23	.075	.67	.67	—	—
Sug.	1.75-2.25	und. .08	.30-.50	.60 .80	—	low
Valve Bushings. See Locomotive Castings and Machinery Castings						
Water Heaters						
—	2.15	.030	.40	.50	—	—
Sug.	2.00-2.25	und. .08	.30-.50	.60 .80	—	—
Weaving Machinery. See Machinery Castings						
Wheels, Large						
—	2.10	.040	.40	.70	—	—
Sug	1.50-2.00	und. .09	.30 .40	.60-.80	—	—

Ref.	Silicon Per cent.	Sulphur Per cent.	Phos. Per cent.	Mang. Per cent.	Comb. Carb. Per cent.	Total Carb. Per cent.
Wheels, Small						
—	2.10	.050	.40	.50	—	—
—	1.60	.083	.60	.39	—	—
Sug.	1.75-2.00	und. .08	.40-.50	.50-.70	—	—
Wheel Centres. See Locomotive Castings						
White Iron Castings						
—	.50	.150	.20	.17	2.90	—
—	.90	.250	.70	.50	—	2.50
Wood Working Machinery. See Machinery Castings.						

Casting a Vapouriser in Brass.

By J. Clements.

The following description of the moulding of a vapouriser for casting in brass shows two different methods; the one with the component parts of the core fitted into their places, and the other being simply a case of reversal, what at the first was the cope side of mould becoming the drag, the cores standing out in relief instead of being embedded. Fig. 1 shows the pattern of the vapouriser (A) and the cover (B). It will be seen,

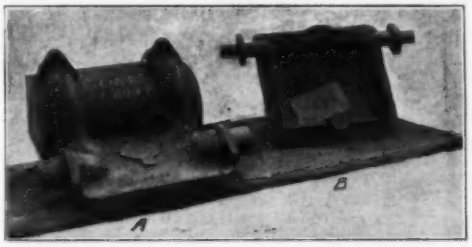


Fig. 1.—Pattern of Vapouriser and Cover.

in the case of the body pattern, that not only have the usual parts to be cored out, but also the core print marked. This, to a certain extent, simplifies the pattern, and at the same time marks one of the latest innovations in pattern-making, the block part containing the under side of the pipes and flanges, these being obtained by the use of the core instead of the pattern comprising them. The lid or cover is also shown from the under-side, one pipe core passing through the top, the reverse side (of the cover) being flat.

Fig. 2 depicts the core boxes. A is the core-box

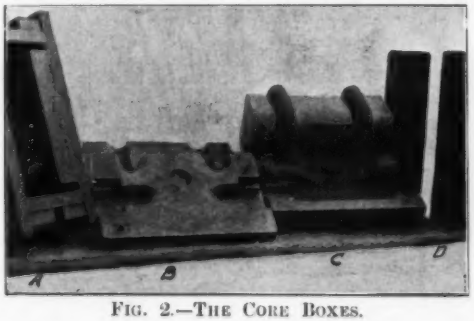


Fig. 2.—The Core Boxes.

for the block with loose piece extending from one side; B, B, are the top and bottom of the core-box for making the body or main core for the vapouriser, in the box being shown a core made

and ready for turning out; C,C, are the core-box top and bottom, for making the core for the cover.

In Fig. 3 are shown the cores made from the boxes depicted in Fig. 2, A being the block core described before—a core that does not present any difficulties in making. B (Fig. 3) is the body or main core, and unlike the last, requires a little more care and skill in making. In the first place a core-iron or wire will be required; the network of the flat or pan part can be made of lighter gauge wire and soldered together, but it will be necessary to make the pipe-like junctions of much stouter gauge wire, at least ¼ in. or ⅜ in. thick, so as to

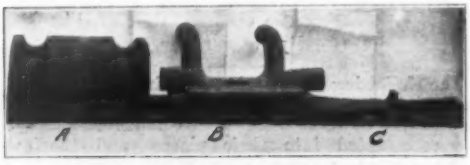


FIG. 3.—CORES MADE FROM BOXES SHOWN IN FIG. 2.

avoid any possibility of springing in taking out the core from box, as this core, owing to its construction, is not easy to turn out after making. The smaller core, C, for the cover is quite an ordinary affair.

In Fig. 4 is shown both the body and lid of the vapouriser made up in the moulds and ready for closing preparatory to casting. In the case of the body, with the cores in position there is little to be seen, and the illustration conveys but a very inadequate idea of the making and arranging of the mould; moreover, the cores after being arranged did not produce quite the satisfaction desired. For instance, in inserting the block core this had to be lowered, and its under ledge inserted under the pan or flat part of the other core. This was found to be far from satisfactory, as whatever happened to it at this stage had to be left, and pushing a dry-sand core into a green-sand mould under the conditions prevailing was undesirable. In making up the second set a different arrangement was therefore adopted, as shown in Fig. 5.

This time the drag side of mould was utilised to

FIG. 4.—BODY AND LID OF VAPORISER MOULDED READY FOR CLOSING.

set out the cores upon, instead of in, by making up the pattern in the mould in the opposite way. This was found a much better procedure. After placing of cores it could at once be seen how the work had progressed, without the uncertainty of the first method. The mould being a good fit and with good length of pins, there was not much to be feared in the way of crushing, and the cores being slightly chamfered, aided the closing of the mould. One drawback, perhaps, remained—once the core was down, down it had to remain, so that the cores upon the drag side of mould had to be carefully located, as failing this no mistakes could afterwards be rectified; but in the case in point no difficulty was experienced.

It may be stated that formerly the vapouriser castings in question had been made in cast iron, the cost being, naturally, much lower than in gun-metal or bronze; but with cast iron it was found that after the expansion had taken place the subsequent contraction was so rapid that the chambers sometimes gave way and cracked; hence the desire to try a more malleable metal. The castings were, accordingly, made in red metal—to be exact, a medium grade of brazing metal, rich in copper, that would stand the amount of heat required and have the requisite amount of ductility to stand the contraction in cooling.

IRON IN ALUMINIUM CHIPS.—Although the employment of aluminium chips in the manufacture of ingots is not exactly to be recommended, still by reason of the quantity of such chips which are produced, it is necessary to utilise them. When using

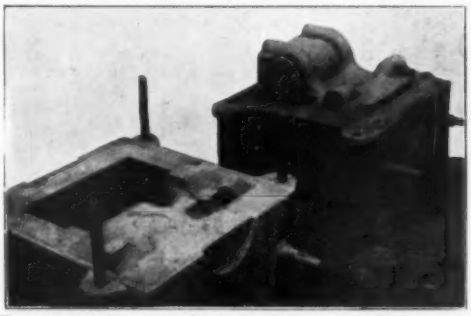


FIG. 5.—ANOTHER ARRANGEMENT OF MOULDING VAPORISER.

them, however, care must be taken that they are free from iron or steel chips. But it is no easy task in the shop to keep the aluminium free from the iron and steel. Although a lathe, planing-machine or boring-mill may be well cleaned up before aluminium is worked thereon, there are always crevices in which steel or iron clips collect; and these latter become mixed with the aluminium. Further, there is always the possibility of parts of screws, tools, etc., getting in among the aluminium chips, so that it would be hard to determine with accuracy whether or not the aluminium were free from foreign matter. The colour of the iron and steel resembles so greatly that of the aluminium, that it is difficult to distinguish them when they are once mixed. If aluminium chips which contain iron are melted, there is formed an alloy of the two metals, the proportions depending on the heat employed; but as a rule, all the iron that is present unites with the aluminium. Many metal-melters are astonished that aluminium cast from chips is hard and brittle although the original metal was tough. The reason is the presence of iron. The fracture, also, is short and coarse-grained. If it is remarked in melting that the aluminium is doughy, and that after pouring it is hard, brittle and coarse-grained, it may reasonably be concluded that iron or steel is present. The use of the magnets to take the foreign metal out of the chips before melting, is always advisable in handling such chips.

Foundry Plant and Equipment.

Turbine Blowers.

Among the important points to be considered in the running of a foundry, must certainly be classed the question of the efficiency of the blower. Undoubtedly, many foundries are losing large sums yearly through the employment of inefficient blowers, either through too great a power consumption or through the blast not being up to requirements. In view of this it is interesting to note the nature of the apparatus being installed in up-to-date plants.

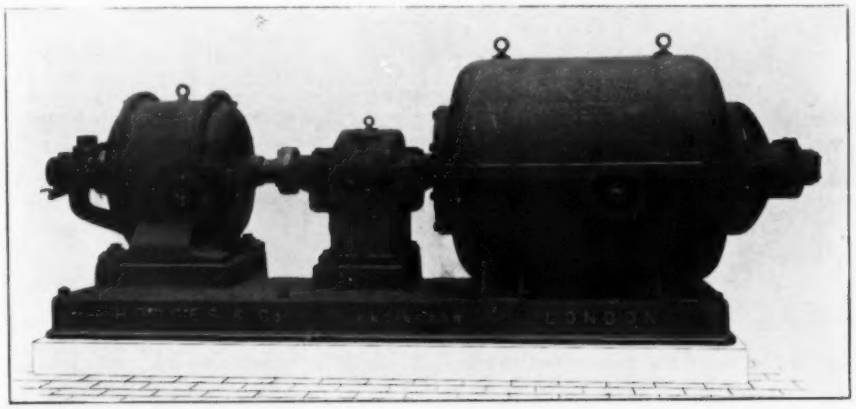


FIG. 1.—TURBINE BLOWER, ELECTRICALLY-DRIVEN, THROUGH SPEED-UP TRANSMISSION GEARS.

In Fig. 1 is illustrated a No. 30 size 6.W.S. standard type Hodges' turbine blower recently supplied to Sir W. G. Armstrong, Whitworth & Company, Limited, for the extension of their anglesmiths' shop at Elswick Shipyard, Newcastle-on-Tyne, to work in conjunction with an older type turbine blower supplied to them by Messrs. Hodges & Company, 14, Devonshire Square, E.C., over seven years ago. The new blower has a capacity of 8,000 cubic feet of blast per minute against 18-in. water-gauge pressure, when running at 1,700 revolutions per minute. It is driven by a 35-b.h.p. Elswick slip-ring induction motor, running at 600 revolutions per minute. Between the motor and blower is interposed a speed-up transmission gear, consisting of a double helical spur wheel of 99 teeth on the driving shaft, and a 35-tooth pinion on the blower shaft, both wheels being 8-in. wide on the face. These gears were cut from solid forgings of high carbon steel, the teeth being staggered. Fig. 2, which depicts the gear case, shows the gears in place, the cover being removed. The end thrust of the blower shaft is taken by the ends of the pinion, while the driver shaft is left free and accommodates itself into equal register with the pinion. In order that no end pressure shall be transmitted from

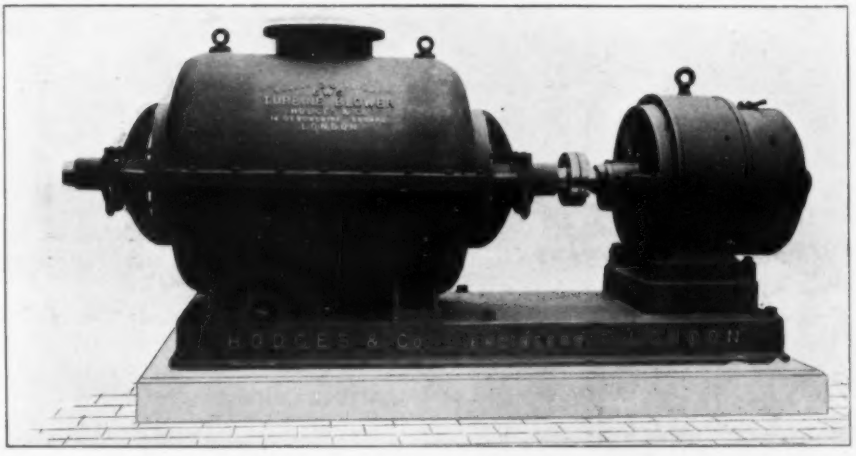


FIG. 3.—TURBINE BLOWER, ELECTRICALLY-DRIVEN, DIRECT COUPLED.

the motor to the gearing, the half coupling on the motor shaft is fitted with fixed driving pins instead of bolts, which pins are free to slide endwise in the corresponding half coupling on the gear shaft. The

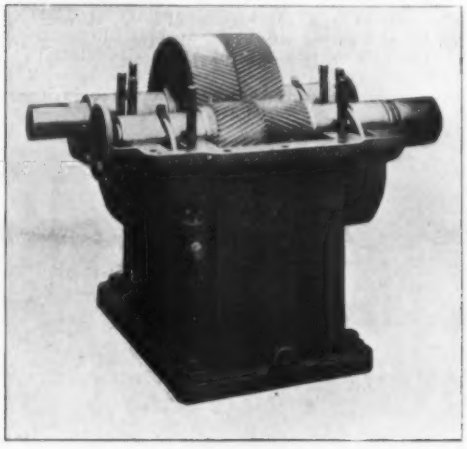


FIG. 2.—TRANSMISSION GEARS FOR TURBINE BLOWER.

lubrication of the gears is effected by means of splash in an oil bath, while all the bearings are fitted with oil-dipping rings and deflectors, which

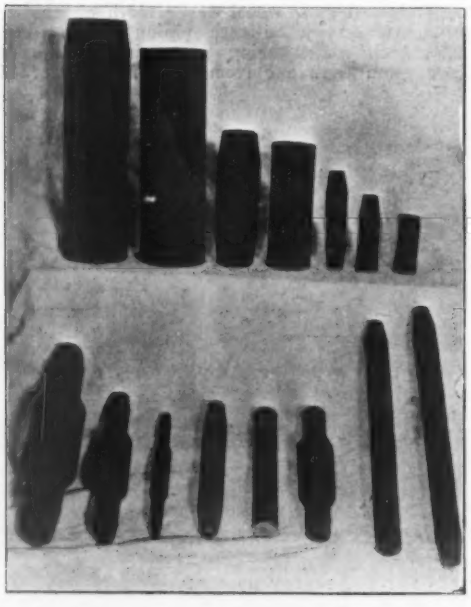


FIG. 2.—CORES FORMED ON THE WADSWORTH MACHINE.

ensure a constant stream of oil flowing through the bushes without the complication of an oil pump.

We understand that Hodges' turbine blowers have been in use at the above-named firm's Ordnance Works, at Newcastle, for over 13 years, while the principal smiths' shop at Elswick Shipyard for over five years has been driven by two Hodges' turbine blowers, which have a combined capacity of 40,000 cubic feet of blast per minute.

In Fig. 3 is shown a similar-sized blower to the above, which was supplied by Messrs. Hodges & Company, last year, to Messrs. Bolckow, Vaughan & Company, Limited, for their new foundry at Middlesbrough. It is direct-coupled to a 40-b.h.p. adjustable speed motor, using continuous current. The connection between the blower and motor are made by flexible coupling, the whole being mounted on a cast-iron base.

The speed is controlled between 1,400 and 2,000 revolutions per minute by a standard ironclad starting and speed regulating panel, fitted with "no-volt" and "over-load" releases, and interlocking

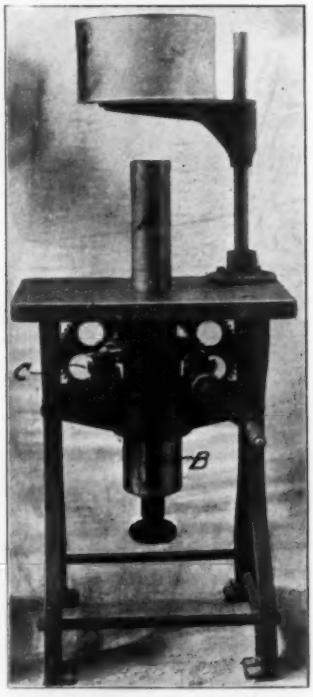


FIG. 1.—FRONT VIEW OF WADSWORTH VERTICAL JAR-RAMMING CORE FORMING MACHINE.

shunt regulating rheostat. The rated output of the blower is 400,000 cubic feet of air per hour at ¾-lb. pressure square inch. At a speed of 2,000 revolutions per minute the blower gives a maximum pressure of 42-in. water gauge, while at 1,750 revolutions per minute the output is 7,600 cubic feet per minute at 20-in. water-gauge pressure.

In ordinary daily work this blower delivers 390,000 cubic feet of blast per hour against 24-in. water gauge, using 60 amperes of current at 450 volts, which at the usual allowance of 30,000 cubic feet per ton of iron melted equals 13 tons per hour, under which conditions the h.p.-current used is only 2.4 per ton, including the friction of the blower, motor and all transmission losses. The space occupied is only 10 ft. by 3 ft. 8 in. by 4 ft. 4 in. high.

A New Wadsworth Core Machine.

For a number of years George H. Wadsworth, of the Falls Rivet & Machine Company, Cuyahoga Falls, has presented the foundry public with a new type of core machine each year, and at the recent Convention in Detroit he had on exhibition a new and interesting type known as the Wadsworth vertical jar-ramming core-forming machine. This is illustrated in the accompanying views. The mechanism is shown in Fig. 1. The machine consists of a table supported upon suitable legs between which the operating mechanism is situated. The core is formed in a vertical shell or core box, sand being supplied from the swinging hopper above the machine. As the sand is fed into the core box or shell the crank at the right is slowly rotated so that the ratchets upon the shafts at each side of the centre of the machine alternately lift and drop the core box or core tube. The stool which supports the entire mechanism for forming the core has projected from it wings in the form of pawls. These wings rest on two ratchets, so that the mechanism is lifted from both sides at the same time. The ratchets are kept in proper position by the gears seen at the back of the machine. The core tube A works in a sleeve B, and is controlled by the adjusting screw C. This screw is first adjusted as to the proper length of core to be made, and then the tube is forced through the table of the machine by lifting the adjusting screw and turning it into the groove at one side of the vertical slot, as shown.

For making an ordinary straight core the straight tube itself is all that is necessary. For irregular cores special dies or core boxes are introduced on the inside of the tube A, and the jarring motion of the machine compacts the sand into the box, causing it to feed out under the shoulders of chamber cores. A group of cores made in this machine is shown in Fig. 2.

A group of the machines shown at Detroit is depicted in Fig. 3. In this illustration all of the dies have been drawn down through the tables. In the three machines at the left the vent rods have been drawn and are lying on the table, while in the three machines at the right the vent rods are in place. At the left of the central spindle of several of the machines can be seen the bushing which is placed in the top of the die to form the upper tapered

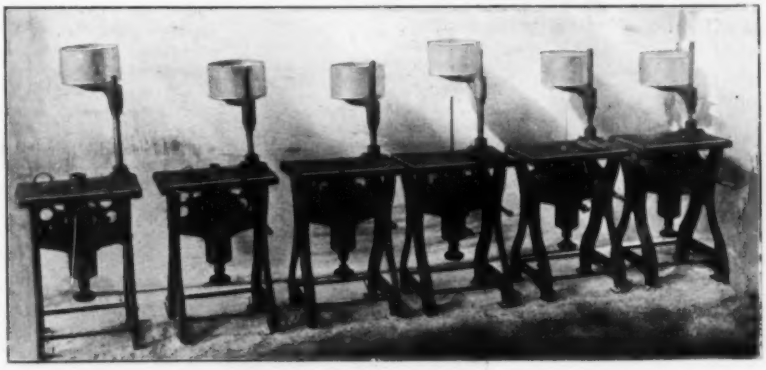


FIG. 3.—GROUP OF MACHINES, DIES WITHDRAWN, WITH DIES DRAWN DOWN THROUGH THE TABLE.

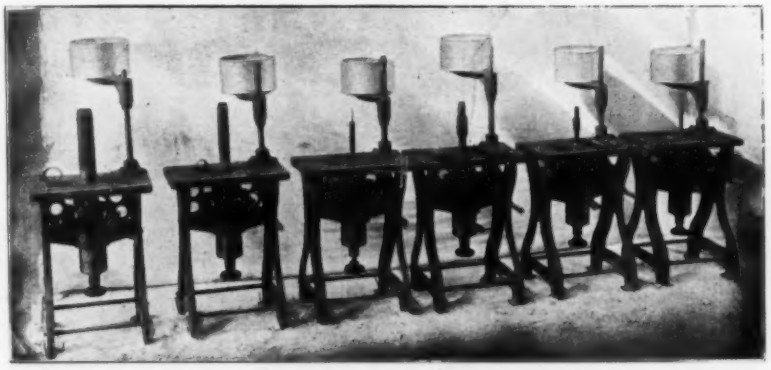


FIG. 4.—MACHINES WITH FINISHED CORES IN POSITION; DIES WITHDRAWN.

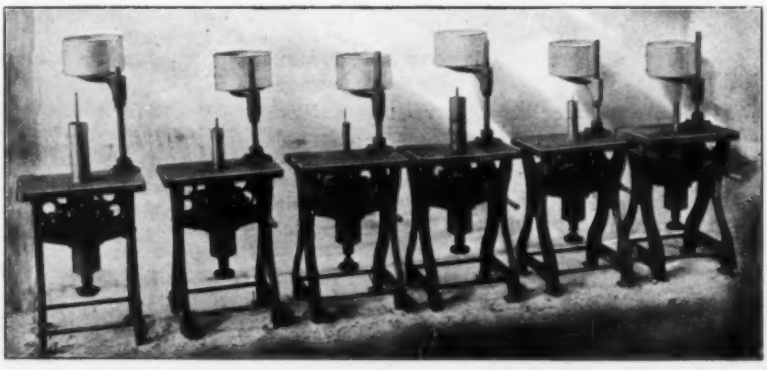
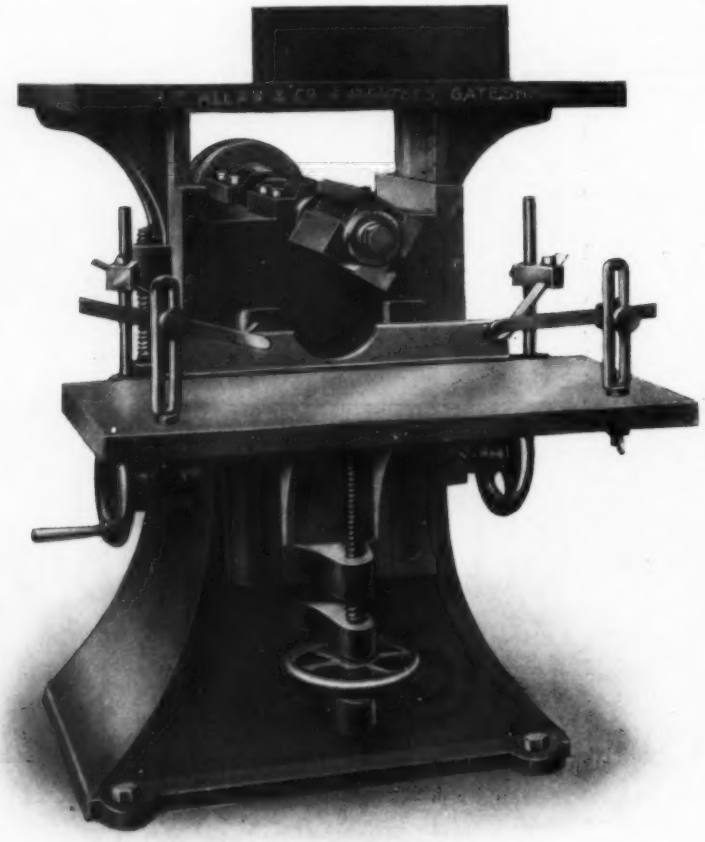


FIG. 5.—MACHINES WITH DIES IN POSITION READY FOR FORMING CORES.

print. At the right of the central spindle on three of the machines can be seen the split core box or special die which is introduced into the machine for forming chambered cores. The lower ends of these die-boxes are tapered in such a way that when the outer casting or tube is drawn down through the table of the machine the dies fall away automatically, leaving the core standing upon the lower stool.

Fig. 4 shows the machine after the cores have been formed. The two cores at the left each have tapered prints top and bottom, and in the illustration the lower tapered print is standing in the lower die. These cores are turned over on to a former or drier which is placed against the side of the core, while it is still in a vertical position. After the core is turned over, the bushing forming the lower tapered print, and which also acts as a stool, is withdrawn from the sand. On the third machine from the left is shown a straight or parallel core. The three machines at the right all show chambered cores. These also have to be turned over on to special driers or pans. Cores with tapered prints can also be dried on end standing in the stool which forms the lower part of the die on the machine. These stools are exceedingly simple in construction, and can be made in quantities on an automatic screw machine so that they furnish very convenient core pans.

The machines with all of the dies in place ready for ramming cores are shown in Fig. 5, and it will be noted that the vent rods project above each one of the dies, thus ensuring a clear vent through the entire length of the core. The vent rods are drawn up out of the cores before the dies are stripped down. In the case of the three machines shown at the left the stripping of the tube or die through the table of the machines leaves the upper thimble for forming the upper tapered print standing on the core. This is picked off by hand and is shown at the left of the machines in Fig. 4.



COMBINED SAW, PLANING AND THICKNESSING MACHINE.

The mixtures for use on this machine have to be somewhat different from those employed in the screw type of core machine. In general, these mixtures approach more nearly those used in multiple core boxes in turning out work by hand. Any good grade of core oil can be used, as well as linseed oil, and a considerable portion of old core sand could be introduced into the mixture. In his own foundry Mr. Wadsworth is using a black core compound as the principal binder. For wetting down he employs glutrin, and he has experimented with several different grades of linseed oil and core oil, all of which have given very fair satisfaction.

A Saw, Planing, and Thicknessing Machine.

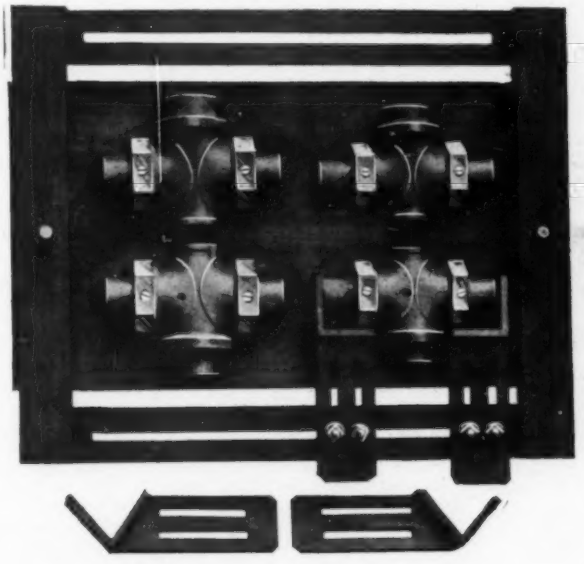
We illustrate herewith a very useful combined saw, planing, and thicknessing machine, suitable for pattern-shop work. The saw table is 26 in. by 22 in., taking a 16-in. saw, and has an adjustable fence. Below the spindle is a second table, 26 in. by 12 in., fitted with four adjustable guides for regulating the work. Each table has a rise and fall of 6 in. The spindle is of powerful make, with cone bearings, and is fitted with a 6-in. cutter-block.

This is an extremely handy tool for sawing, planing, thicknessing, or moulding, particularly for small pattern shops, though, of course, it is suitable for all classes of shops. The planer will make a cut ¼ in. deep at the rate of 30 ft. per minute.

The makers are Messrs. R. S. Allan & Company, Victoria Buildings, Gateshead-on-Tyne.

Method of Operating Setting-Out Frames.

One of the most frequent contentions against the adoption of moulding machines is the want of orders in quantities. This is a great mistake, as with proper appliances it often pays to put so small a number as half-a-dozen castings on the machine, and with this object there has been introduced by Mr. James Pickles, Victoria Works, Bradford, a setting-out frame. The illustration shows the method of dealing with split patterns of various kinds. Supposing an order comes in for six castings of one kind, nine or 12 of another, and so on. One half pattern is mounted in any convenient position on the board or plate, as shown, fixing by the screws. The gauges are then let up on the frame to the pattern and secured by the bolts. The frame is then turned over and the other half pattern let up to the gauges, which ensures the halves matching each other, when the complete mould is made. Further, by this method two complete castings from the one pattern are got, thus saving half the pattern bill. The operations are repeated with any suitable patterns until the board or plate is full, and when sufficient moulds have been got from any particular pattern, that one is removed and replaced with others. This method answers for either split or flat-back patterns, and effects a great saving of labour and cost of patterns.



PICKLES' SETTING FRAMES FOR PATTERNS.

A Useful Core-Oven.

The core-oven illustrated herewith has several features to recommend it. It is claimed that by its use considerable economy in fuel is effected, and the cores are dried at a uniform heat. The oven, also, requires very little attention. The style shown in Fig. 1 is a self-contained oven, with four shelves 5 in. deep and one 10 in. deep. The firegrate is fitted on one side of the oven, and gives a good uniform heat.

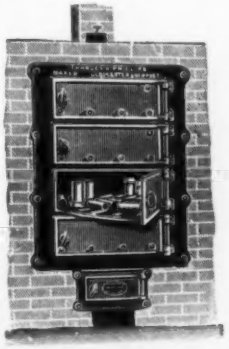


FIG. 1.—CORE OVEN BUILT IN WALL.

FIG. 2.—SELF-CONTAINED CORE OVEN.

The oven shown in Fig. 2 is made with a cast-iron front plate to fix in a brick wall, and is fitted with four cast-iron radial shelves. Each shelf is bolted to the door, the door swinging on hinges bolted to the front plate. The fire-grate is separate so that it can be built in the brickwork directly under the oven shelves.

The maker of these ovens, which are very suitable for burning gas coke, is Mr. Charles D. Phillips, Emlyn Engineering Works, Gloucester.

Inventions.

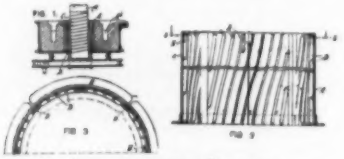
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

14,806. Moulding-boxes. E. J. H. Plötz.
14,864.*Burners for cutting metal or for autogenous welding. H. Knapp.
15,022.*Moulding-machines. (Osborn Manufacturing Company, United States.)
15,139.*Electric furnaces. C. Hering.
15,164.*Resisters of electric furnaces. J. Thomson.
15,165.*Revoluble or oscillatory electric furnaces. J. Thomson.
15,166.*Electric furnaces. F. A. J. Fitzgerald.
15,167*, 15,168*, and 15,169.*Electric furnaces. J. Thomson.
15,507.*Pyrophoric metal alloys. H. Beck.
15,863.*Apparatus for casting metal by pressure. S. Enomoto.
15,892. Alloys. P. R. Parsons and O. Silberrad.
15,984.*Hardening of iron and steel. G. Dabritz.
16,314. Vacuum casting machines. F. H. Wright, 41, Reform Street, Dundee.
16,325. Machines for preparing sand moulds for castings. N. F. Longley.
16,511.*Furnaces for melting metals. H. J. Mundy.
16,536.*Grinding machines. D. E. Plaisted.

Abstracts of British Patent Specifications recently accepted.

27,972 (1909). *Electric Furnaces.* J. Hay, manager of the Grondal Kjellin Company, Limited, 20, Abchurch Lane, London, E.C.—Figure 1 is a sectional elevation of an electric induction furnace provided with an improved metallic shield; Figure 2 is a sectional elevation of the metallic shield drawn to a larger scale; Figure 3 is a horizontal section on the line 3—3 of Figure 2. A is the metallic shield, with which the inner wall of the annular heating or fusion chamber A^1 is lined. C is the primary or other winding, which is wound upon the iron core C^1. B B represent the spiral ribs upon the surface of the metallic shield A. The heat radiated from the metallic shield into the space between the shield and the core C^1 causes an upward draught of hot air which is continually being replaced by fresh cold air,

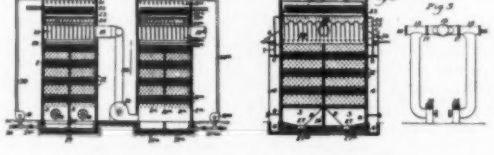


Hay's Electric Furnace.

and the latter, by sweeping over the extensive radiating surface of the metallic shield, prevents an undue amount of heat from reaching the primary winding C. The ribs, owing to their spi al formation, offer very little opposition to the upward flow of the air, but they materially increase the strength of the metallic shield. The heat from the annular fusion chamber is of itself sufficient to create an upward draught of air through the space or passage between the shield and the core, and this is in most cases sufficient to keep the metallic shield cooled, but the natural draught may if desired be supplemented by a forced draught. For convenience of manufacture and to facilitate the fitting of the shield to a chamber of any external shape, the said shield may be made in sections. In Figure 3, for example, the circular shield is shown composed of sections, two or more of which are joined by rivet plates E, and the portions thus assembled are connected to each other by dowels D of insulating material.

21,419 (1909). *Carburizing Iron, Iron Alloys, and Mild Steel.* W. R. Hodgkinson, 89, Shooters Hill Road, Blackheath, S.E.—According to this invention the iron, iron alloy, or mild steel, is submitted to the influence of the vapours of nitrogenous, or nitrogen-containing benzenoid compounds, or the products resulting from the decomposition, or partial resolution by heat, of such vapours, whilst the metal is heated to the requisite temperature. The nitrogenous benzenoid compounds which are suitable for use for the purposes of the invention are the primary amines, such as aniline, toluidine, the naphthylamines, etc., and their salts, or compounds, with acids such as the acetates, the formates, the phosphates, etc., and the formyl, and acetyl, and like derivatives such as formanilide, acetnilide, and similar compounds, and also the secondary amines and tertiary amine, and amine derivatives such as pyridine, quinoline, etc., and their salts, or compounds with acids such as the acetates, the formates, the phosphates, etc., and substances of the type of phenylhydrazine and their salts, and the amides, or the ammonium salts of benzenoid acids, such as ammonium benzoate, ammonium naphthoate, etc. The inventor prefers to spray, inject, or drop, the carburising agent into the muffle or furnace. The introduction should be made so that the muffle or furnaces is maintained full of the vapour during the period of heating. The temperature employed and the time occupied in the operation determine the depth of carburisation, the longer the time and the higher the temperature, the greater being the depth of carburisation. For example, the metal can be sufficiently carburised for some purposes by subjecting it to the vapour of, say, pyridine, or of aniline, or of acetanilide, for about thirty minutes at a temperature of from 650 deg. to 800 deg. Centigrade. Small articles can have a very hard surface given to them, and will not be unduly distorted, if the operation be carried on at a temperature of about 750 deg. Centigrade.

13,554 (1909). *Method of and Apparatus for Drying Air.* J. Gayley, 71, Broadway, New York, U.S.A.—Figure 1 is a sectional side elevation of apparatus constructed in accordance with the invention; Figure 2 is a vertical section at right angles to Figure 1; and Figure 3 is a detail view of the pipe connections between the towers. 2 represents the first cooling tower, shown as divided into four chambers 3, each provided with an external air duct 4, of sheet metal or other suitable material. The upper end of this duct 4 is open, and preferably protected by a spaced apart roof 5. These ducts are of considerable length, and spray devices 6 are arranged in their upper portion, to which water is supplied through pipes 7. This spray will filter away the coarser impurities of the air, and also cool it somewhat. The lower ends of the ducts terminate in catch basins 8, where the dirty water is collected and led to the sewer. The lower portions of the ducts open into the lower ends of the chambers 3,

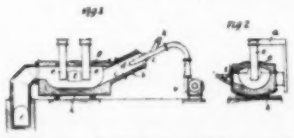


Apparatus for Drying Air, by Gayley.

and the ports are provided with fans 9, which will force the air from the ducts into the cooling chambers against the resistance of the sprays in the chambers. Inclined baffle plates 11 are placed at the lower ends of the cooling chambers, opposite to the fans, to deflect the air upwardly, and as the air rises it is preferably split up by grids or grate-work, consisting of round wooden poles 12, which are impregnated to resist the rotting

action of the water. At the top of the tower, the air is led through pipe 13, to fans 14, through branch pipes 15, and thence to the second cooling tower 2a. The branch pipes 15 are, as shown in Figure 3, provided with valves 17, whereby the cooling tower may be shut off from the refrigerating building fans, and with valves 18, which can be opened to allow the outside air to pass directly to these fans 14.

18,610 (1909). *Process and Apparatus for Heating, Melting, Refining and Extracting Metals.* H. Hoff, Düdelingen, Luxemburg.—Fig. 1 is a sectional elevation of one form of a combined coal-dust fired and electric furnace; Fig. 2 is a transverse section of the same. The electrode furnace *h*, protected by a sheet iron casing, is rotatably mounted on the foundation, so that it can be tilted by a mechanical device and its contents discharged. The electrodes *e* are adjustably suspended on projecting arms *a*, and can be lifted out of the arch, and lowered into the interior of the furnace, by a suitable lifting device. The coal-dust burner consists of a cylindrical pipe *b* lined with fireproof material into which the nozzle *d* of the air-blast pipe *l*



Apparatus for Heating, Melting Refining and Extracting Metals.

projects, the coal dust being supplied by the pipe *k* connected with the blast pipe. The amount of coal dust supplied may be controlled by a suitable regulating device of some known type. At the other end of the furnace is attached an exhaust flue *f* for the products of combustion. Both the burner *b* and the exhaust flue *f* can be detached and lifted away from the furnace casing when it is desired to heat the furnace electrically, the resulting apertures being closed by fireproof doors to prevent loss of heat. For adjusting the electrodes automatically during the electrical heating stage, an automatic regulation of any suitable type may be employed.

13,218 (1909). *Manufacture and Treatment of Steel.* H. A. Richardson, Hyde Park Hotel, Knightsbridge, London, S.W.—The invention consists in forming the plates or articles from ingots made from an alloy containing about 1 per cent. of molybdenum and about 0.2 to 0.5 of carbon, and subjecting such plates or articles to a cementation process whereby a glass-hard surface is produced without quenching. An alloy is prepared containing molybdenum 1 per cent., nickel 4 per cent., and carbon 0.3 per cent., by any suitable melting process, by which a pure steel free from phosphorus and sulphur can be obtained. For the purpose of the manufacture of armour plates, the ingots of this composition are rolled to the desired thickness of plate, and the plates covered with oak charcoal or other carbon on one surface, and carburised, as is usual in the cementation process. Other articles can be formed, and their surfaces treated in a similar manner. By the above treatment a plate having a glass-hard surface is obtained without quenching. In the process the nickel may be replaced by cobalt.

27,201 (1909). *Iron Product and Open-hearth Process of Manufacturing Same.* The International Metal Products Company of Newark, New Jersey, and Middletown, Ohio, United States of America.—The present invention provides an iron having in an exceptionally high degree the quality of malleability. The manufacture may be realised in detail in the following manner:—First, employ a high-powered basic open-hearth furnace, that is, one which is capable of withstanding what might be termed a particularly "fierce" action, above that hereinafter specified as the minimum temperature to be attained in carrying the process into effect. Second, charge the furnace with pig-iron, or cast iron, or molten iron, preferably employing iron whose phosphorus and sulphur and silicon do not aggregate over 3.05 per cent. Sand-cast pig-iron is preferably to be avoided. In practice, there has at times been substituted low carbon iron or steel scrap to the extent of 80 per cent. of the charge. Third, a charge of lime or limestone is employed to reduce sulphur and phosphorus, same being introduced into the furnace either prior to, simultaneously with, or subsequent to the charging of the metal, according to furnace conditions and nature of charge. Fourth, proceed to refine the charge as in making soft steel, by the employment of iron ore or agitation, or both. Recarburization with pig-iron in case the charge melts specially low in carbon is not essential at this stage, as it would be in the process of making low carbon steel. Fifth, raise the temperature as the carbon becomes reduced, and pro'ong the refining operation till analysis by bath test shows that the sulphur phosphorus, manganese, carbon, and silicon do not in the aggregate exceed 0.14 per cent. For the best results, it is desirable and practicable to reduce this aggregate to less than one-half this percentage, and to have neither carbon nor manganese over 0.02 per cent. In practice it is found that this treatment (under its most favourable conditions) will consume from one to four hours more time than is employed in making high-grade soft steel, that is to say, the making of a heat of soft steel which with cold metal ordinarily requires about 9 hours from the beginning of the charging to the tapping period (when the test shows, say, 0.10 per cent. of carbon, and about the same percentage of manganese), whereas in the production of our product the treatment will be continued to, say, a total period from charging to tapping of from 10 to 13 hours, until as above stated, the test shows an aggregate of not over 0.14 per cent. of sulphur, phosphorus, manganese, carbon, and silicon, and preferably less than one-half such percentage. Sixth, let the tapping temperature reach at least 2,850 deg. F., and then tap the molten hot charge into a ladle or other receptacle. Seventh, pour into ingot moulds or other moulds while the metal is still at high temperature. At some stage after the fifth stage has been completed, either in the furnace, during tapping into ladle, or pouring into moulds, or subsequent to being poured into moulds, the molten metal is to be deoxidized and degasified to such extent that the resulting product will contain not over 0.05 per cent. of oxygen as determined by the method of Ledebur, and preferably considerably below this, and will contain at least 99.80 per cent. of iron. No special removal of the slag is requisite, but it may be tapped out with the metal, and all or a portion of it allowed to float on the metal on the ladle for its heat protection, any surplus overflowing.

9,508 (1909). *Process of Refining Metals and Alloys.* Albert Edwards Greene, 6,028, Jackson Park Avenue, Chicago, Illinois, U.S.A.—This invention relates to the process of refining metals or alloys of metals in which the undesired impurities are removed by subjecting the metal when in a molten state to the influence of a suitable gas containing oxygen, which is blown under pressure through the molten metal. The claims in connection with this invention are:—(1) The process of refining metals and alloys by eliminating therefrom an undesired oxidizable element. The material under treatment is maintained, by heat from an external source, at a temperature at which the oxygen-affinity of the elements which it is desired to eliminate is greater than the oxygen-affinity of the elements which it is desired to retain, and in the meanwhile subjecting the material to the action of a gaseous mixture having oxidizing properties with respect to the former elements at the temperature maintained, but which has reducing properties with respect to oxides of the latter elements at such temperature, the desired reactions being controlled by a combined regulation of the temperature of the bath and the composition of the gaseous mixture. (2) The gaseous mixture contains a gas which *per se* would act as an oxidizing agent for the oxidizable

elements of the bath, and also contains a gas which *per se* would act as a reducing agent for the oxides which would be formed in the bath by the said first-named gas, said gases being mixed in suitable proportions to cause the said gaseous mixture to act as an oxidizing agent with respect to the oxidizable elements which it is desired to eliminate from the bath, and at the same time to act as a reducing agent for the oxides of the element or elements which it is desired to retain in the bath. (3) The gaseous mixture employed contains carbon dioxide (CO_2), and also carbon monoxide (CO). (4) The material is treated in an electric furnace, and the desired temperature is maintained by regulating the flow of electric current. (5) For removing two or more oxidizable elements successively from the mixture under treatment, the mixture is heated to progressively varying temperatures, each different temperature corresponding to that at which the element to be eliminated has a higher oxygen-affinity than the elements to be retained. (6) Prior to the treatment with the gaseous mixture described, the undesired elements are partially eliminated by subjecting the molten material to the action of a gas having relatively high oxidizing properties. (7) In the process applied to a metal containing sulphur or phosphorus, or both sulphur and phosphorus, a flux suitable for forming slag compounds with sulphur and phosphorus is added to the material under treatment. (8) The treatment of the material is continued by subjecting the bath to the further action of a gaseous mixture having reducing properties with respect to said flux. (9) The gaseous mixture employed for reducing the flux contains a high percentage of carbon monoxide (CO).

Correspondence.

The Use of Moulding Machines.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—The correspondence in your columns on this subject is certain to have only one result, *i.e.*, to give the foundryman a greater interest in machine-moulded castings, and to disperse the prejudice which exists in the minds of so many otherwise clever foundrymen. In last month's issue "J. R. M.'s" concluding paragraph goes to the root of the matter, but fortunately, English makers of moulding machinery are now waking up, and it is a fact that we can now build machines in England even superior to foreign-made articles.

Take, for instance, your report of the visit of the Birmingham Branch of the British Foundrymen's Association to the Daimler Motor Company's Works at Coventry. You mention the fact that at these works there are five machines made by a Coventry firm.

Now when a firm like the Daimler Company buy five machines, English made, from one firm, it certainly seems to point to the fact that they must have a great liking for this particular machine, and, to my mind, they must be superior to the other makes of foreign moulding machines.

It would be interesting to learn (although, I suppose, it is asking to much) what the Daimler Company themselves think of these English machines, compared with the foreign machines they have in use.

Yours truly,

GEO. H. FOSTON.

Query.

Moulders' Ready Reckoner.

Can any reader give the name of the publishers of "Neaves' Moulders' Ready Reckoner," or, failing that the name of a similar publication?

H. W.

Deaths.

MR. P. JENKINS, brass founder, of Rhyddings, Neath, died last month, after a long illness.

MR. J. VAUGHAN, brassfounder, of Collyhurst and Harpurhey, died recently, aged 80 years.

MR. J. W. THORNES, of Messrs. Thornes & Company, engineers, Bradford Road, Dewsbury, died recently.

THE death is announced of Mr. A. H. M. Driver, chief engineer to the Birmingham Small Arms Company, Limited, aged 67 years.

MR. J. LEWIS, at one time a well-known ironfounder at Kidderminster, died recently. He retired from active business four years ago, but his son has since carried on the foundry. He was 72 years of age.

MR. HARRY TAYLOR, one of the heads of the managerial staff of Thomas Firth & Sons, Limited, Sheffield, with which firm he had been associated for 44 years, died recently, at the age of 57 years.

THE death occurred at his residence, Edgbaston, Birmingham, recently, of Mr. Arthur Latch, managing director of Messrs. Latch & Batchelor, Limited, of Hay Mills, Birmingham. Mr. Latch had been very closely associated with the wire rope trade for very many years.

THE death took place at the Grange, Hunnington, near Halesowen, on Thursday, June 30, of Colonel C. E. Smith, head of the firm of Messrs. Edward Smith & Sons, Brunswick Tube Works, Wednesbury. Deceased, who was 65 years of age, was taken ill last week, and was found to be suffering from pneumonia, gradually becoming worse until he died.

THE death is reported from Sheffield of Mr. George Hamer, who for many years was connected with the iron and steel industries of that centre. He commenced work with Messrs. John Brown & Company, and stayed with the firm until the formation of William Cooke & Company, Limited, when he went with Mr. Cooke to Tinsley, and acted as departmental manager. He continued in that capacity for 36 years, and only retired from active service about six years ago.

THE death is announced of Mr. Patrick Walter Meik, M.Inst.C.E. Mr. Meik was for many years head of the firm of Thomas Meik & Sons, Edinburgh, and one of the principal assistant engineers in connection with the construction of the Forth Bridge. He had the carrying out of numerous extensive dock and other building schemes, including dock works at Burntisland, Bo'ness, Eyemouth, and Warkworth. He was engineer, too, for the Forfar and Brechin, Gifford and Garvald, and Newburgh and East Fife Railways, for the great dock and railway works at Port Talbot on the Bristol Channel, and for the large graving dock built for the accommodation of Dreadnoughts on the Tyne.

WE regret to announce the death at Harrogate of MR. James Riley, who was widely known in connection with the Scottish iron and steel industry. Mr. Riley was born at Halifax in 1840, and as a youth was engaged in mechanical engineering. Leaving Halifax, he went to Middlesbrough, finding occupation at the Ormesby Works. In 1869 he was appointed manager of the Askham Iron and Steel Company's Works at Barrow, and four years later he took charge of the blast furnaces of the Landore-Siemens Steel Company, and accomplished the feat of producing spiegel iron from manganiferous Spanish ore. In 1874 Mr. Riley became general manager of the Landore Company, but subsequently went north, and took over the general direction of the works of the Steel Company of Scotland. In that capacity he popularised mild steel for boiler-making, bridge-building, and other purposes. In 1887 Mr. Riley received the Bessemer medal "for his valuable services to the open-hearth industry, especially in developing the manufacture of mild steel of high quality." In 1894 he transferred his services to the Glasgow Iron and Steel Company. Subsequently he severed his connection with that company in order to undertake the manufacture of iron and steel on his own account at the Richmond Works, at Stockton-on-Tees.

Trade Talk.

Mr. A. R. Findlay, engineers' furnisher, has removed to 33, Robertson Street, Glasgow.

Mr. F. C. Billing, who represents Gwynnes, Limited, in the Yorkshire district, has just removed to 80, Burcot Road, Sheffield.

The Electromotor Equipment Company, Limited, have removed from 6, St. Bride Street, E.C., to 326, Old Street, E.C.

Hans Renold, Limited, have been awarded a gold medal for their exhibit of steel driving chains at the Japan-British Exhibition.

Simplex Conduits, Limited, have opened a branch office at 12, Gascoigne Street, Boar Lane, Leeds, under the charge of Mr. W. Kay.

The Kestner Boiler Company have removed from 3, Newmans Court, Cornhill, London, E.C., to 17, Fenchurch Street, London, E.C.

E. Lomer & Company, Limited, 110, Fenchurch Street, London, E.C., have been appointed British agents of G. Vandelièvre et Fils, Lille, France.

Mr. J. Walton, 28, Cavendish Road, Stretford, Manchester, has been appointed sole Lancashire and Yorkshire agent for Messrs. W. Geipel & Company.

An outbreak of fire occurred recently at the Bloomsbury Foundry, Wolverhampton, belonging to Messrs. W. Lea & Company, doing considerable damage.

The Victoria Iron and Steel Company, Limited have appointed Messrs. J. McMillan & Bolton, of 38, Lime Street, London, E.C., sole agents in London.

The metal business of the Zivnastenska Banka (London Agency), St. Benet Chambers, Fenchurch Street, London, E.C., has been transferred to Prague.

The United States Steel Products Export Company have removed from 71 & 72, King William Street, London, E.C., to Egypt House, 36-38, New Broad Street, London, E.C.

The Thames Ironworks Shipbuilding and Engineering Company has booked an Admiralty order for the supply of machinery to a second-class cruiser under construction at Chatham.

The discharge from bankruptcy has been refused of Mr. C. Humphries, lately carrying on business under the style of the Midland Foundry Company, Great Bridge, Tipton, Staffs.

Messrs. J. Owen and N. Owen, metal smelters, Adelaide Road, Shepherd's Bush, London, W., trading under the style of the Frictionless Bearing Metal Company, have dissolved partnership.

Messrs. R. Nevill & Company's foundry at Llanelly caught fire recently, and although the outbreak was extinguished in two hours, considerable damage was done, particularly to stores and patterns.

The Cannon Iron Foundries, Limited, Deepfields, near Bilston, have acquired the business of the Windsor Foundry Company, Birmingham. We understand that the business will be transferred to Deepfields.

The Machinery Exhibition in Manchester, organised by the "Engineering Review," is to be opened in October by the Right Hon. Sir Geo. Reid, the High Commissioner for the Commonwealth of Australia.

We have received from Messrs. Neale & Wilkinson, Limited, 32, St Mary Axe, E.C., their new booklet of rates for the conveyance of goods to all parts of the world. A copy will be sent by the firm post-free on application.

The contemplated formation of a Metallurgical Society of Sheffield has been received with considerable approval. A general meeting is to be held on August 29 to complete the arrangements for the inauguration of the Society.

Wm. Hunt & Sons, The Brades, Limited, of the Brades Steel Works, near Birmingham, have established offices at 40, 41, and 42, Finsbury Court, Finsbury Pavement, London, E.C. Mr. W. J. Benslyn is now the company's agent for London and district.

Messrs. Royce, Limited, of Trafford Park, Manchester, have received an order from the Daily Telegraph Paper Mills, Dartford, Kent, for a gantry and electrical overhead crane with jib attachment for unloading and stacking bales of paper pulp. The span of the crane is 110 ft.

Messrs. J. Stone & Company, Limited, mechanical engineers, Deptford, have installed a number of gas-fired furnaces, made by the Richmond Gas Stove and Meter Company, Limited. Each furnace carries about 5 cwts. of metal, and the heat is generated on a patented gas and hot air principle.

A serious fire occurred at the Tube Works of Messrs. Howell & Company, Limited, Wincobank, Sheffield, on June 28, as a result of which one of the most important departments was partially wrecked. The machinery escaped with but little injury, but extensive damage was done to the building.

The London County Council has decided to make a maintenance grant of £8,000 to the Imperial College of Science and Technology, South Kensington. In return for this grant it secures the privilege of nominating 25 students for one year's free instruction at the Imperial College. These are now to be filled for the first time.

The Council of the Junior Institution of Engineers (Incorporated), in conjunction with the Council of the Society of Engineers (Incorporated), have arranged for a course of six fortnightly lectures, on "The Law relating to Engineering," to be delivered by Mr. L. W. J. Costello, M.A., LL.B. (Cantab.), the first to be given on October 10 next.

The Kelham Forge and Rolling Mills were sold by auction last month as a going concern for £16,000, the purchaser being T. W. Ward, Limited, iron and steel merchants, etc., of Sheffield. The purchase includes nine rolling mills, 21 furnaces, and other plant and machinery, as well as a large quantity of billets and finished steel and scrap metal.

For the convenience of their British customers, the Humboldt Engineering Works, of Kalk, near Cologne, have formed a British company in London, under the style of The British Humboldt Engineering Company, Limited, with registered offices at their former address, viz., Dixon House, Lloyd's Avenue, London, E.C. Mr. Walther Hasendahl has been appointed secretary of the new concern.

An arrangement has been arrived at between the Dominion Iron and Steel Company, Nova Scotia, and the new steel merger, known as the Steel Company of Canada, whose five constituent companies are situated in Montreal, Toronto, Hamilton, and intermediate points. The arrangement is on the basis of spheres of influence, and it entirely removes anything approaching competition between the two companies.

According to an official French Customs notification bars of hard steel, round, hectagonal, octagonal, etc., of a diameter of from 2½ to 3 centimetres, pierced throughout their length with a hole varying from 5 to 9 millimeters in diameter, are to be dutiable as "other tools" (Tariff No. 537) at the rate of 22 fcs. per 100 kilogs when imported into France. The former classification of this steel was as tubes.

The Northamptonshire Direct-Castings Company, Limited, of the Irthlingborough Iron Works, Wellingborough, have disposed of the whole of their business and assets to Thos. Butlin & Company, Limited, who will henceforth carry on the business. The whole of the directors of the former company are also directors of the purchasing company, and the whole of the staff have been taken over by that company.

It is interesting to note that the Witkowitzer-Bergbau-und Eisenhutten-Gewerkshaft, Witkowitz, Austria, are about to adopt the Talbot process of steel making. For very many years the company in question have worked the duplex system; in fact, they were amongst the pioneers of this process. A large gas-fired preliminary refining furnace is to be put down, and the metal afterwards treated by the Talbot process.

Extensive damage was done recently by a fire which occurred at the Callendar Ironworks, Falkirk. The

outbreak occurred in the works warehouse, in which a large quantity of finished castings were stored. The works brigade, assisted by the burgh fire brigade, succeeded in extinguishing the outbreak. The roof of the warehouse, a large brick building, was, however, practically destroyed, and the goods stored in the place were also damaged.

COLONEL SIR HILARO BARLOW, Chief of the Royal Arsenal, Woolwich; Major J. Rawdon Stansfield, Inspector of the Naval Inspection Staff; and Mr. H. Moore, of the Royal Research Department, have lately visited a number of Swedish iron works, particularly those where the manufacture of steel is carried on. Such well-known works as the Uddeholm, Nykroppa, Storfors, Sandviken, Avesta, Fagersta, Kolsva, Boiors, etc., have all been inspected.

WE understand that a private issue has been made of £40,000 4½ per cent. first mortgage debentures of Henry Bessemer & Company, Limited, part of £75,000 authorised. The price of issue was, we believe, 101 per cent., the bonds being registered in the names of applicants free of all expense. The debentures are redeemable by the company at any time between December 31, 1916, and December 31, 1923, at 105 per cent., and any not previously redeemed will be paid off at par on the latter date.

THE EDGAR ALLEN AMERICAN MANGANESE STEEL COMPANY, McCormick Building, Chicago, has taken over the Chicago Heights plant of the American Brake Shoe and Foundry Company, devoted to the manufacture of manganese steel castings of all kinds, and has improvements under way which will more than double its capacity. The same company recently acquired the steel casting foundry of the Tropenas Steel Company at Newcastle, Del., which is also being greatly enlarged. The directors of the company are Messrs. R. Ortmann, J. B. Terbell, J. C. Ward, J. G. Gallagher and O. H. Cutler. Mr. Ward is also a director of Edgar Allen & Company, Limited, Imperial Steel Works, Sheffield, England, and is at present in charge of its Chicago and New York branches.

MESSRS. EVERITT & COMPANY, LIMITED, iron, metal, and general merchants, 40, Chapel Street, Liverpool, have been appointed by the Primos Chemical Company, of Delaware, Co. Pa., U.S.A., the sole selling agents for their vanadium alloys and compounds, in conjunction with two other firms. The American company have three grades of ferro-vanadium, viz.:—Grade A. containing 20—25 per cent. Va.; Grade B, containing 35—40 per cent. Va.; and Grade C, containing 25—30 per cent. Va., the latter two being practically carbon free. Grade A is suitable for open-hearth furnace work, and in connection with steel castings; it contains 5 per cent. carbon and 6 per cent. manganese, and its specific gravity is the same as steel.

THE LONDON PHOSPHOR, COPPER, AND BRONZE COMPANY, who have been carrying on a very successful business in Poplar for the last twelve years, has acquired the entire assets, including the works, of the Phosphor Bronze Company, Limited (in liquidation), who have offices and works both at Southwark and in Aston, near Birmingham. The businesses have been amalgamated and are being continued under the name of the Phosphor Bronze Company, Limited, which company will take over all existing contracts. Mr. Walter Lester, who was the proprietor of the London Phosphor, Copper, and Bronze Company, has been appointed managing director and chairman of the newly-formed company. We understand that the capital of the new concern is £100,000.

THE SHEFFIELD CUTLERS' COMPANY are taking action in connection with an application made in the United States by a wagon undertaking styling itself the Sheffield Car Company, carrying on business at Three Rivers, Michigan, for the registration of the word "Sheffield" as a trade mark. The Cutlers' Company have cabled to the Commissioner of Patents at Washington urging that the mark should be stopped on the ground that it can be used only as a false indication of origin. The Cutlers' Company have also filed an opposition to the mark on the ground, among other objections, that it is the name of a well-known manufacturing city of England, and that no person can obtain as his exclusive property the name of a city which is the common heritage of all citizens living and carrying on business therein.

SIR JOSEPH JONAS, who has been elected president of the Sheffield Branch of the Free Trade Union of South Yorkshire, in the course of some remarks at a meeting on July 4, asked why so many steel firms failed in this country. It was, he said, because of the importation of bounty-fed steel from Germany at less than cost price. If Free Trade was abused, he declared, it must be protected. It was commercially wrong to send goods into this country under cost price. They in Sheffield did not want their works shut up. He had tried to approach the Prime Minister on this matter, but without success. He hoped the Free Trade Union would take it up and put the subject before the proper authorities. Foreigners could send what they liked into this country, but it must not be at less than cost price, or British manufacturers could not exist.

WITH reference to the call of the Transvaal Government for the erection of a local plant for the manufacture of steel from iron and steel scrap, it is notified that the proposals of Messrs. Gilbert Walker and Donald F. Campbell on behalf of the South African Steel Corporation, Limited, have been accepted. The Corporation will shortly be registered in the Transvaal with a capital of £200,000, and will be floated under the auspices of the Société Electro-Metallurgique Française—the owners of the Hèroult furnace patents—and of Messrs. Edgar Allen & Company, of Sheffield and Johannesburg. The consulting engineers will be Sir Charles Metcalfe and Sir Douglas Fox & Partners. The Board of Directors will be resident in London, but the managing director will be Mr. Donald F. Campbell. The initial plant will consist of one 5-ton Hèroult furnace for the electric smelting of scrap. A feature will be made of drill-steel, and among the thirty or forty expert workmen who will be imported for the industry will be some of the best men from the leading Sheffield steel works.

New Companies.

ALUMINIUM PLANT AND VESSEL COMPANY, LIMITED.—Capital £5,000 in £1 shares.

WHITEHEAD BROS., LIMITED.—Capital £12,000 in £1 shares, to carry on the business of engineers, founders, etc.

E. CAPPER, ROBSON & COMPANY, LIMITED.—Capital £500 in £1 shares, to carry on the business of iron and steel masters, etc.

FORTIS ENGINEERING COMPANY, LIMITED.—Capital £2,000 in £1 shares. Registered office: 17, Hertford Street, Coventry.

MOUNTAIN ENGINEERING COMPANY, LIMITED.—Capital £2,000 in £1 shares. Registered office: 11, Queen Victoria Street, E.C.

ATLANTICA, LIMITED.—Capital £5,000 in £1 shares, to carry on the business of shipbuilders, etc. Registered office: 54, Billiter Buildings, E.C.

WELDINGS, LIMITED.—Capital £1,500 in £1 shares, to carry on the business of engineers, etc. Registered office: 80½, Lionel Street, Birmingham.

VALITE, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of acetylene engineers, etc. Registered office: 13, Buckingham Street, Strand, W.C.

W. H. DE RITTER & COMPANY, LIMITED.—Capital £10,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 33, Three Colt Street, Limehouse, E.

COMPLETE
Foundry Equipment.
Telegrams: "LADLES" MANCHESTER
Telephone: "N° 2297 CENTRAL" MANCHESTER.

JAMES EVANS & Co. BRITANNIA WORKS,
BLACKFRIARS, MANCHESTER.

HUGH ALEXANDER TANK COMPANY, LIMITED.—Capital £500 in £1 shares, to carry on the business of ironfounders. Registered office: 13, Broomfield Avenue, Palmer's Green, N.

HARRY CROSSLEY & COMPANY, LIMITED.—Capital £500 in £1 shares, to carry on the business of brass founders and finishers, etc. Registered office: Perseverance Works, 42, Corporation Street, Halifax.

CHAINS, LIMITED.—Capital £10,000 in £1 shares (2,000 preference, 1,000 "A" ordinary, and 7,000 "B" ordinary), to carry on the business of manufacturers of and dealers in chains of all kinds, engineers, founders, etc.

JAMES M'EWAN & SONS, LIMITED.—Capital £5,000 in £10 shares, to acquire the business of James M'Ewan & Sons, ironfounders, Cyclops Foundry, Whiteinch, Glasgow. Registered office: Cyclops Foundry, Whiteinch, Glasgow.

RICHARD IBBOTSON, THE SHEFFIELD SAW AND TOOL COMPANY (COMBINED), LIMITED.—Capital £7,500 in £1 shares, to take over the business of saw and tool manufacturers, carried on at Whitecroft, Sheffield, as Richard Ibbotson, The Sheffield Saw and Tool Company (Combined).

PENSHER FOUNDRY COMPANY, LIMITED.—Capital £3,000 in £10 shares, to take over the business of an engineer, ironfounder, and manufacturer of colliery and general castings, carried on by E. A. Crow at Pensher, Durham, as the Pensher Foundry Company, and to adopt an agreement with E. A. Crow and G. B. Hodsman.

NOKES & CANNON, LIMITED.—Capital £2,000 in £1 shares, to adopt an arrangement with E. S. Nokes and J. J. Cannon for the acquisition of the business of mechanical and electrical engineers formerly carried on by E. S. Nokes at Canning Street, Leicester, as Clerk & Nokes. Registered office: Canning Street, Leicester.

PETTER'S LIMITED.—Capital £150,000 in £1 shares (75,000 6 per cent. preference), to take over the business of engineers, ironfounders, and oil-engine manufacturers carried on at Nautilus Works, Reckleford, Yeovil, and at 61-63, Queen Victoria Street, E.C., by James B. Petter & Sons, Limited. Registered office: 7-8, Walbrook, E.C.

REGISTER OF BRITISH MANUFACTURERS, LIMITED.—Registered as a company, limited by guarantee, with not more than 200 members, each liable for two guineas in the event of winding up; to protect the interests of British manufacturers and merchants; to combat the fraudulent marking of foreign-made goods as "British," and to promote the sale of British manufactures in preference, etc.

BRAZILIAN IRON AND STEEL COMPANY, LIMITED.—Capital £100,000 in £1 shares, to carry on the business of ironmasters, steelmakers and converters, coke manufacturers, miners, smelters, engineers, tinplate makers and founders, etc., to acquire and turn to account gold mines, mining rights, and auriferous land in any part of the world, and to adopt an agreement with A. T. Teniers. Registered office: Finsbury Pavement House, Finsbury-Pavement, E.C.

Personal.

SIR CHRISTOPHER FURNESS has assumed the title of Lord Furness of Grantly on his elevation to the peerage

MR. R. E. HIGHTON, commercial manager of the Moss Bay Works of the Workington Iron and Steel Company, Limited, has resigned.

THE late Colonel John Edward Cutler, a director of William Jessop & Sons, Limited steel manufacturers, Sheffield, left estate valued at £77,768.

MR. G. F. ELLIS has just retired from his position as divisional engineer and locomotive superintendent of the Cambrian Railways at Builth Wells.

THE RT. HON. STUART WORTLEY, M.P., is to be presented with a public testimonial in recognition of his 30 years' services to Sheffield in the House of Commons.

MR. HENRY NICHOLSON, who has been with John Spencer & Sons, Limited, Newburn Steel Works, Newcastle-on-Tyne, for the past 50 years, latterly as manager of the steel-casting department, has just retired.

MR. A. SHORT, previously assistant manager at the Tyne Engine Works, Barry Dock, has been appointed superintendent engineer to Messrs. J. & C. Harrison, of London.

THE gross value of the estate of the late Mr. E. Wright, of Granville House, Wellington Road, Edgbaston, vice and anvil manufacturer, is £27,779, with net personalty £27,669.

SIR GEO. S. GIBB announces that in consequence of his appointment as Chairman of the Road Board, he is obliged to retire from the directorate of the Dunderland Iron Ore Company, Limited.

MR. ALEX. TURNBULL has resigned the managing directorship of Alexander Turnbull & Company, Limited but will still remain as chairman and technical adviser to the company. Mr. W. H. Youden has been elected a director of the company.

MR. C. M. RAMSEY, previously first Vice-President of the Crucible Steel Company of America, has been elected President of that company, to succeed Mr. Herbert Du Puy, who only succeeded the late Mr. F. B. Smith until a new President could be determined upon.

MR. JOHN SUMMERS, of Inglewood, Stalybridge, ironmaster, a director of Messrs. John Summers & Sons, Limited, of the Globe Ironworks, Stalybridge, and of the Hawarden Bridge Ironworks, Chester, who died on May 20 last, aged 53, left estate of the gross value of £177,580, of which the net personalty has been sworn at £175,419.

MR. H. C. ELSE and MR. J. H. WILKINSON have been appointed joint managing directors of William Cooke & Company, Limited, iron, steel, wire rod, and rope manufacturers, of Tinsley, Sheffield, in succession to the

(*Continued on page* 442.)

EFFICIENT AND ECONOMICAL HEATING OF FOUNDRY STOVES,
. . . ANNEALING OVENS, FURNACES, &c. . . .

R. & G. HISLOP,

Gas Engineers, Underwood House, PAISLEY.

SOUND

STRONG, CLOSE-GRAINED

CASTINGS

Obtained by using

"TITANIUM THERMIT"

TINS READY FOR USE. **ALL SIZES from 2 cwt. to 20 tons.**

Prices and Particulars from

THERMIT LIMITED,

Telegrams: "FULMEN, LONDON."
Telephone: 3749 Central.

27, Martins Lane,
Cannon Street, E.C.

Works: **210a, Bow Rd., E.**

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Navigation Collieries, Ltd., Cardiff.

late Mr. Thomas Wilkinson. The office of chairman will continue to be filled by Mr. W. D. Holford, who took over the duties on the death of Mr. Thomas Wilkinson.

Mr. Joseph Fellows, of Osborne House, Walsall Road, King's Hill, Wednesbury, well-known in iron trade circles and associated with the James Bridge Steelworks, and also with the Bestwood Iron Company, who died on May 17 last, aged 61 years, left estate valued at £22,194 18s. 7d. gross, with a net personalty of £14,345 7s. 11d.

In September this year Sir Andrew Noble, Bart., K.C.B., F.R.S., D.C.L., chairman of Sir W. G. Armstrong, Whitworth & Company, Limited, will celebrate the jubilee of his connection with the Elswick Works. It has been decided to confer the Honorary Freedom of the City of Newcastle upon Sir Andrew Noble, in recognition of his distinguished services in the cause of science during his 50 years association with the city.

Major-General Edward Micklem has been elected chairman of the board of directors of Greenwood & Batley, Limited, in place of the late Mr. Arthur Greenwood. Mr. Henry Greenwood has relinquished his position as managing director, retaining his seat on the board. Mr. Sidney Townend Batley and Mr. Thomas Greenwood have been appointed managing directors of the company.

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 10s. 0d.; light wrought, £1 7s. 6d.; heavy cast, £2 8s. 0d.; all per ton f.o.b., London. Copper (clean), £50 0s. 0d.; brass (clean), £38 0s. 0d.; lead (usual draft), £12 0s. 0d.; tea lead, £11 0s. 0d.; zinc, £18 10s. 0d.; all per ton delivered merchant's yard.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

Metals.	End July, 1910.	End July, 1909.
Iron—Scotch pig warrants ton	*54.9	*54 4½
—Middlesbro' warrants ton	49 2½	48 9
—W.C. M/nos Bessemer ... ton	66 -	58 6
—Stock, Scotch ... .. tons	1,000	1,000
Copper—Chili bars, GMB ton	£54 7 6	£59 0 0
—Stock, Europe and afloat tons	†103,957	167,379
Tin—English ingots ... ton	£148 10 0	£132 0 0
—Straits ... ... ton	£149 2 6	£132 10 0
—Stock, London, Holland, U.S.A., and afloat ...tons	†16,452	†18,734
Lead—English pig ... ton	£13 0 0	£13 0 0
Spelter—Ord. Silesian .. ton	£22 7 6	£22 0 0
Quicksilver (75lb)... bottle	£8 12 6	£8 5 0
Antimony—Regulus .. ton	£29 10 0 £30 10 0	£32 10 0

* Settlement price. † June 30.

Castings.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1½ to 2½ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 10 0	to	3 12 6
Floor plates (open sand)	3 0 0	to	3 5 3

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

Ironfounders' Charcoal Blacking, Mineral Blacking, Coal & Coke Dust Manufacturer,
&c.
JAMES SYKES, HURST CHARCOAL MILL, Near ASHTON-UNDER-LYNE.
ESTABLISHED 1854.

Established 1863.

JAS. DURRANS & SONS,

PHŒNIX WORKS, PENISTONE, Near Sheffield.

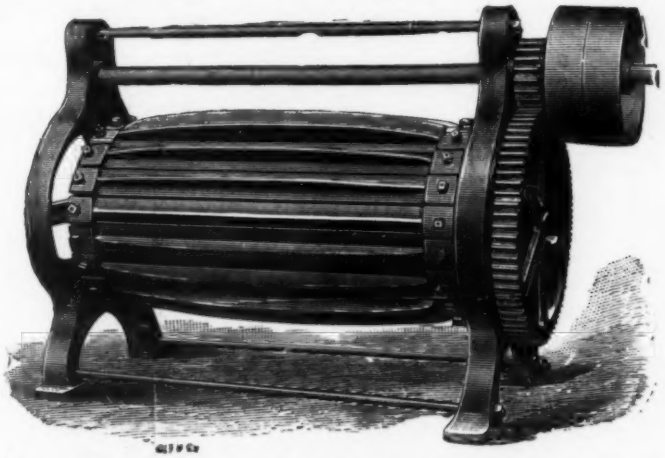
Manufacturers of all

FOUNDRY EQUIPMENTS,

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

HOW MUCH does RIDDLING by HAND Cost You?

Can You do it for 3d. per Ton?

That's just about the cost of Riddling with these **STAND AND WALL SAND RIDDLES.** The machines are arranged for belt drive, and to take ordinary 18 in. riddles. The holder has a simple catch so that the riddle can be changed in a few seconds. They are built to wear, take little power and floor space, and cost of maintenance is practically nil.

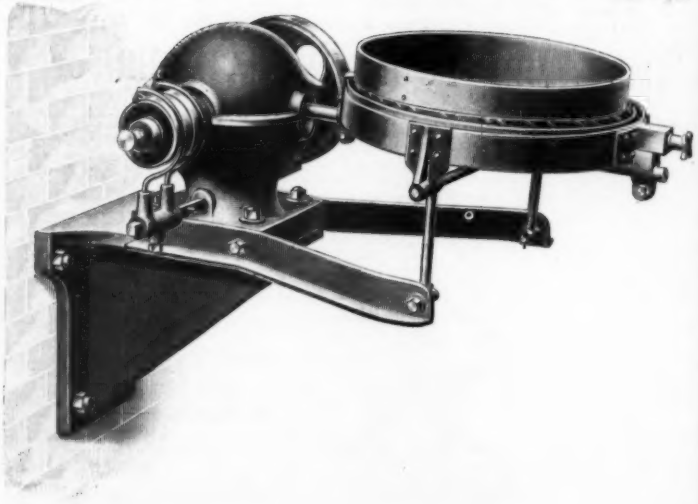
Price, Complete,

£16 0 0.

We also make

SAND MILLS.
SAND MIXERS.
MOULDING MACHINES.
CORE MAKING MACHINES.
SAND BLAST APPARATUS.
ABRASIVE WHEELS.

The best and cheapest Emery Grinders on the Market.



The London Emery Works Co., PARK WORKS, TOTTENHAM, LONDON, N.

THE BUYER'S GUIDE

Addresses and further information will be found by reference to the Firm's Advertisement.

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London Emery Works Co.
Jackman, J. W., & Co., Ltd.

Air Compressors.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Electrically Driven).
Jackman, J. W., & Co., Ltd.
Marshall & Co. Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Steam).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Air Compressors (Belt).
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

Annealing.
Phillips, J. W. & C. J.

Ash Crushing and Washing Machines.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

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Alldays & Onions Pneumatic Eng. Co., Ltd.
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Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co.
Phillips, J. W. & C. J.
Tilghman's Patent Sand Blast Co., Ltd.

Barrows.
Durrans, J., & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.

Bellows.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Durrans, Jas., & Sons.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Blacklead.
Durrans, J., & Sons.
Evans, J., & Co.
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Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

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Buffalo Forge Co., Ltd.
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Jackman, J. W., & Co., Ltd.
London Emery Works Co.
Marshall, H. P., & Co., Ltd.
Phillips, J. W. & C. J.
Samuelson & Co., Ltd.
Thwaites Bros., Ltd.
Ward, T. W., Ltd.

Buffing and Polishing Machines.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

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Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Pneumatic Engineering Appliances Co., Ltd.
Tilghman's Patent Sand Blast Co., Ltd.

Cement.
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Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.
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Marshall & Co., Horace P.
Olsen, Wm.
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Silent Machine and Eng. Co.

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Olsen, Wm.
Wilkinson, T. & Co., Ltd.

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Evans, J., & Co.
Jackman, J. W., & Co, Ltd.
Sykes, James.
Walker, I. & I.

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Davies, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Thwaites Bros., Ltd.

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Cumming, Wm., & Co., Ltd.
Durrans, J., & Sons.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Sykes, James.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Coke (Foundry).
Elders Navigation Collieries.

Coke Breakers.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W., & C. J.

Core Boxes.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.

Core Compounds.
Cumming, Wm. & Co., Ltd.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W. & Co., Ltd.
Olsen, Wm.
Wilkinson, Thos. & Co.

Core Gums.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Walker, I. & I.
Wilkinson & Co., Thos., Ltd.

Core Making Machines.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co
Marshall, H. P. & Co.
Phillips, J. W. & C. J.

Core Ovens.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J. & Co.
Hislop, R. & G.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Phillips, C. D.
Phillips, J. W. & C. J.

Core Ropes.
City of London Wood Wool Co.
Durrans, J. & Sons.
Evans, J., & Co.
Hall, Charles, & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.
Wilkinson, T. & Co.

Core Vents.
Bush, Henry C.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Olsen, Wm.

Cranes.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Jackman, J. W., & Co., Ltd.
Vaughan & Son, Ltd.
Ward, T. W., Ltd.

Crucibles.
Hall, Charles, & Co.
Olsen, Wm.

Crucible Furnaces.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Crucible Furnaces (Lift-out)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Phillips, J. W. & C. J.

Crucible Furnaces (Tilting)
Alldays & Onions Pneumatic Eng. Co., Ltd.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.
Phillips, J. W. & C. J.

Crushing Mills.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.

Cupolas.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davies, T. & Son.
Durrans, J. & Sons.
Evans, J., & Co.
Jackman, J. W. & Co., Ltd.
London Emery Works Co.
Marshall, H. P. & Co.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Cupola Linings.
Evans, J., & Co.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
Marshall & Co., Horace P.

Emery Grinders.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Davis, T., & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Emery and Glass Cloth and Glass Paper.
London Emery Works Co.

Emery Wheels.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Jackman, J. W., & Co., Ltd.
London Emery Works Co.

Fans.
Alldays & Onions Pneumatic Eng. Co., Ltd.
Buffalo Forge Co.
Davies, T. & Son.
Evans, J., & Co.
Jackman, J. W., & Co., Ltd.
Jenkins, W. J. & Co., Ltd.
Phillips, J. W. & C. J.
Thwaites Bros., Ltd.

Firebricks.
Durrans, J. & Sons.
Dyson, J. & J.
Harris & Pearson.
Jackman, J. W., & Co., Ltd.
King Bros.
Lowood, J. Grayson, & Co., Ltd.
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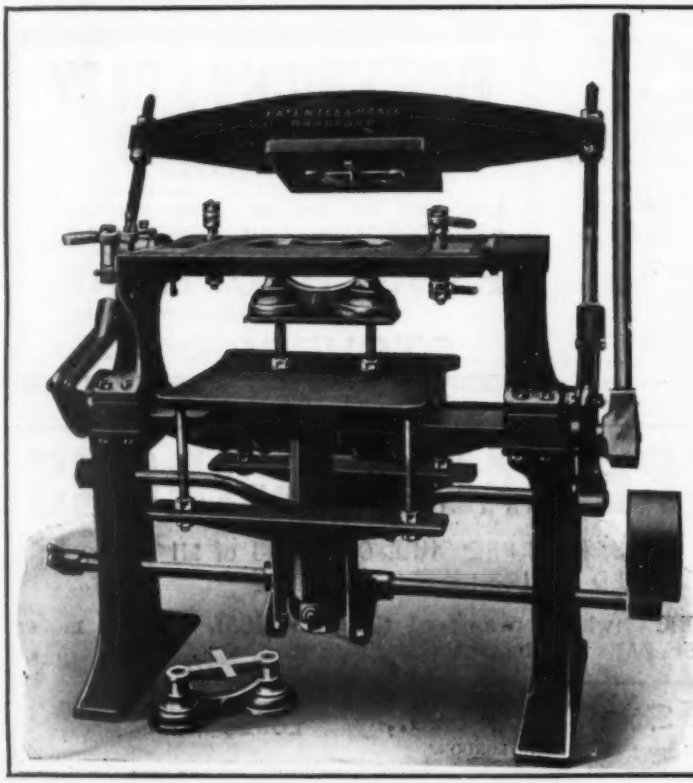

The accompanying illustration shows the Pickles' Patent Moulding Machine used with a stripping plate, and half the pattern being withdrawn through the plate, and half being from the top of the mould, this being the centre part of a 3-parted . . mould. . .

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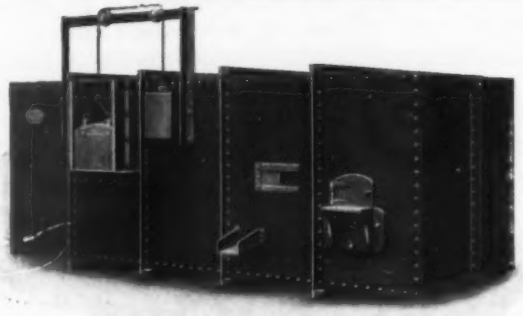

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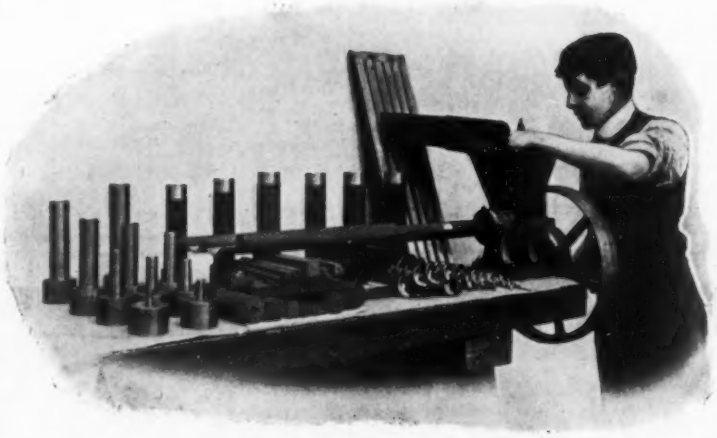

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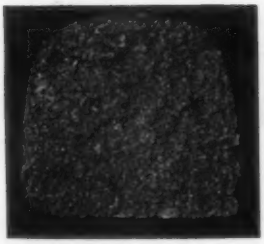
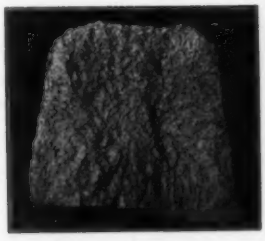
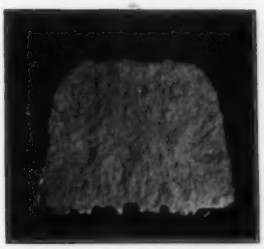

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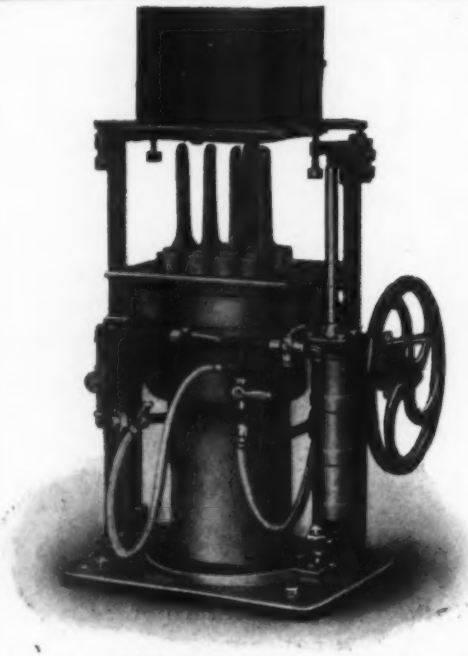

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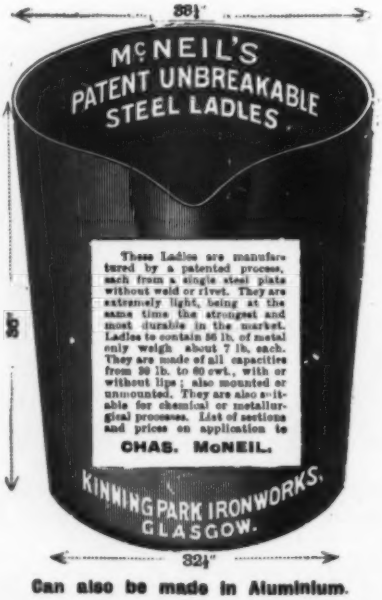
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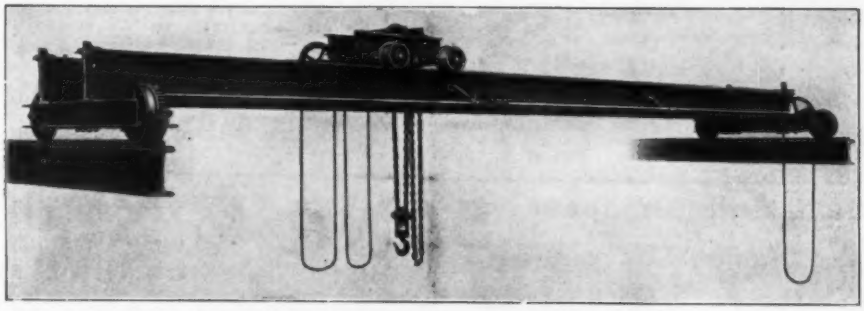

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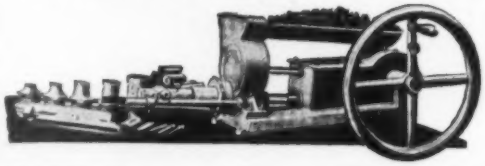

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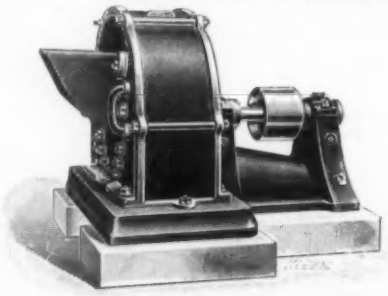

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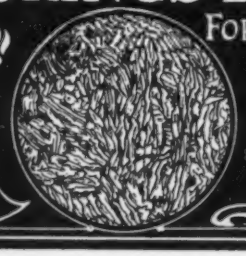

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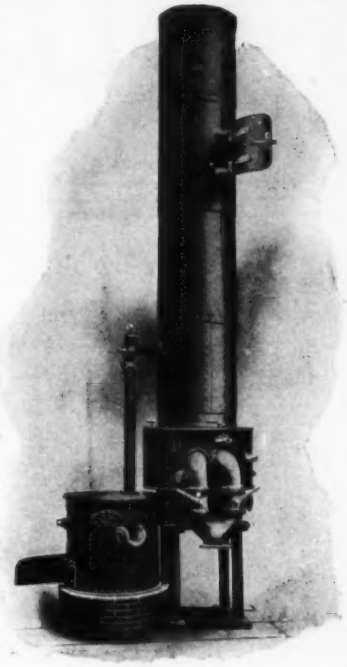

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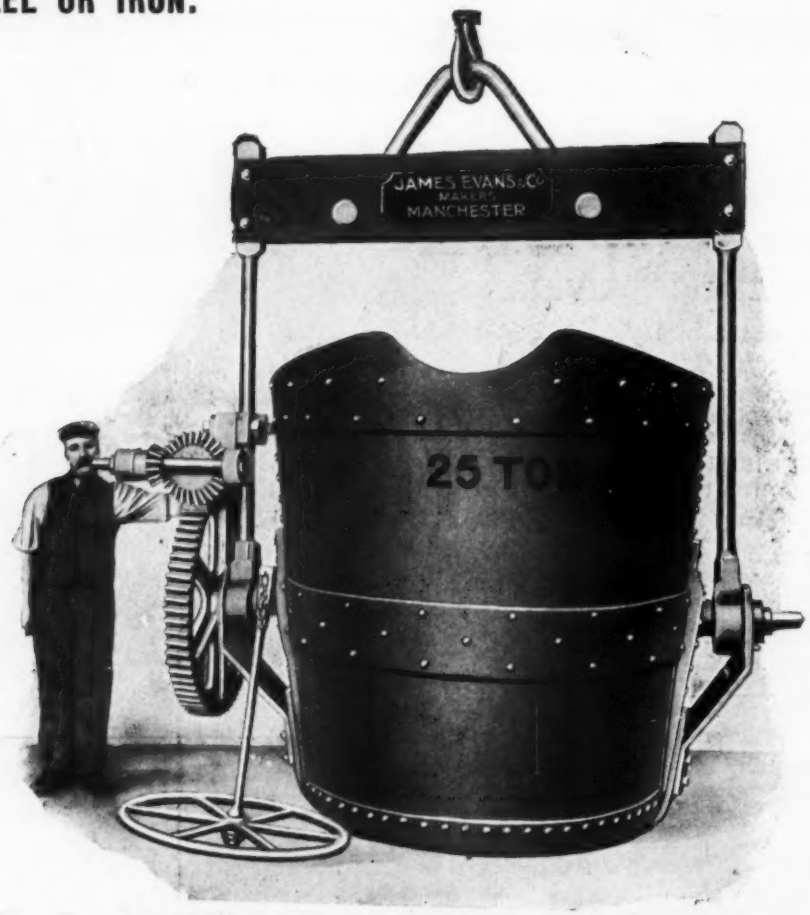

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